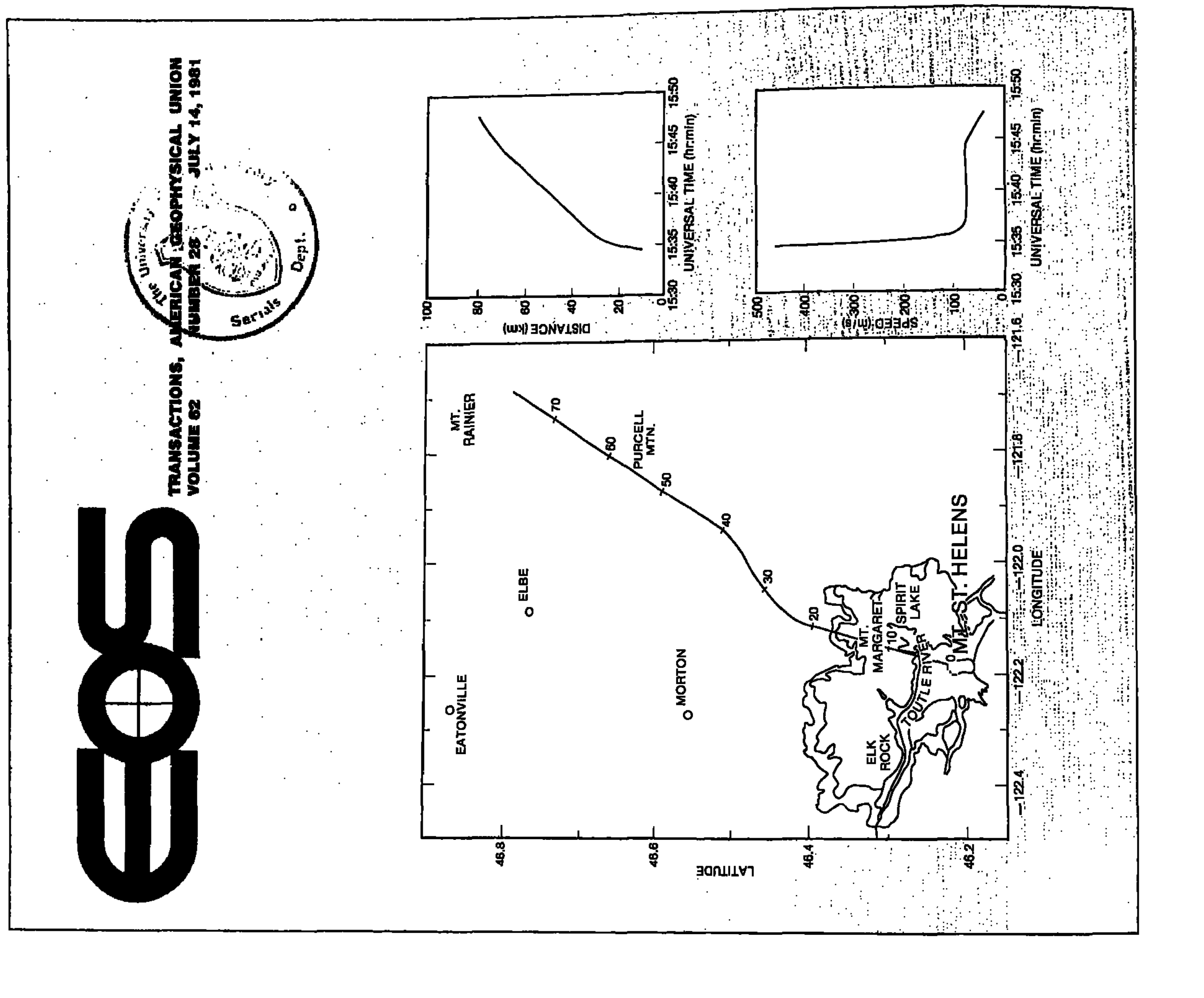

EOS, TRANSACTIONS, AMERICAN GEOPHYSICAL UNION VOL. 62, NO. 28, PAGES 577-584 JULY 14, 1981

Oceanography

4705 Boundary layer and exchange processes
SEASONAL VARIATIONS IN THE UPPER ARCTIC OCEAN AS OBSERVED AT T-3
James Morison (Polar Science Center, University of Washington, 4057 Roosevelt Way NE, Seattle, WA 98105) and J. Dungan Smith, Geophysics Program, University of Washington, Seattle, WA.

Hydrographic data from T-3 are analyzed to illustrate the behavior of the Arctic mixed layer. The mixed layer depth fluctuates 31 m annually and mixed layer salinity fluctuates 0.32 ‰. The fluctuations in total salt content are consistent with theoretical work by Maykut and are in phase with mixed layer depth, indicating changes in the mixed layer are controlled by salt flux. Deepening of the mixed layer brings 0.3 kcal cm^{-2} yr^{-1} of heat to the surface from the ocean below.
Geophys. Res. Lett., Paper 1L0793

4710 Chemical oceanography
CALCULATING THE OCEANIC CO_2 INCREASE: A NEED FOR CAUTION
Alan M. Shiller (Scripps Institution of Oceanography, University of California, San Diego, La Jolla, California 92093)

A number of workers have presented calculations attempting to show the anthropogenic CO_2 increase in the ocean. These workers back-calculate the CO_2 concentration of a water parcel to when it was at the sea surface by using well-known ratios to correct for chemical changes induced by biological decomposition. Because of the potential significance of these CO_2 back-calculations, their limitations are examined here. In the Antarctic Intermediate Water, which has served as a primary testing ground for these back-calculation models, mixing is seen to significantly alter chemical concentrations. However, previously used mixing corrections are shown to have little effect on an analogous back-calculation of preformed nitrate. Additionally, the results of the CO_2 back-calculations are probably too high for the water mass in question. Thus the ability of these methods to provide reliable estimates of the oceanic CO_2 increase is in doubt. (Carbon dioxide increase, antarctic intermediate water).
J. Geophys. Res., Green, Paper 1C0909

4713 Circulation
CIRCULATION OF THE CARIBBEAN SEA: A WELL-RESOLVED INVERSE PROBLEM
Dean Roemmich (Woods Hole Oceanographic Institution, Woods Hole MA 02543, U.S.A.)

The Caribbean Sea is selected as a region where the large scale circulation is well determined by historical hydrographic measurements through application of the inverse method. A simple example is used to illustrate the technique and to demonstrate how some physically relevant quantities may be well determined in the formally underdetermined inverse problem. The geostrophic flow field in the Caribbean is found by imposing mass and salt conservation constraints in seven layers separated by surfaces of constant potential density. An unsmoothed solution is displayed which has weak dependence on an initial choice of reference level. In addition, a unique smoothed solution is shown.

Above σ_θ = 27.4, the total flow leaving the western Caribbean is estimated to be 29 × 10^6 m^3 sec^{-1}, in agreement with direct measurements. This flow is made up of 22 × 10^6 m^3 sec^{-1} entering the Caribbean from the east and flowing across the southern half of the basin as the Caribbean Current, and 7 × 10^6 m^3 sec^{-1} entering from the north through Windward Passage. Both of these currents show small scale variability that diminishes with distance from the respective passages. The deep flow has no net transport, as required by the shallow exit, but a well organized clockwise recirculation is found in the deep eastern Caribbean. (Caribbean Sea, inverse method, general circulation).
J. Geophys. Res., Green, Paper 1C0850

4750 Sea ice
SEA ICE DISPLACEMENT FROM SEASAT SYNTHETIC APERTURE RADAR
R. T. Hall (Polar Science Center, University of Washington, 4057 Roosevelt Way NE, Seattle, WA 98105) and D. A. Rothrock

Images obtained by a synthetic aperture radar on SEASAT have been used to measure sea ice displacements over a three day interval in October 1978. The position of a natural ice feature was measured on 5 October and again on 8 October; the difference in these two positions is a displacement. The displacement of many features was measured. The tracked features lie roughly along a line and are quite dense—about 2 km apart—over a distance of 865 km. The displacements are about twenty kilometers. Displacement errors grow with distance from shore becoming as large as 3 km. The graph of displacement versus distance has occasional discontinuities of several kilometers. Displacement discontinuities are accurate to ± 0.07 km along track and 3% of their magnitude across track. (SEASAT)
J. Geophys. Res., Green, Paper 1C0948

4765 Surface waves, tides and sea level
STATISTICAL ANALYSIS OF THE TSUNAMIS OF THE ITALIAN COAST
Michele Caputo (Istituto di Fisica "G. Marconi", Università degli Studi, Roma, Italy) and Gianfranco Faita.

The study of a catalogue of tsunamis of the Italian coasts allows to assign the intensity to 1 0 6 tsunamis of the catalogue which are listed accordingly. The statistical analysis the data of this list since the year 1000 suggests the tentative density distribution

$$\log n = 3.00 - 0.425 I$$

where n is the number of tsunamis of intensity I per thousend years. (Statistics, tsunami, Italian coasts).
J. Geophys. Res., Green, Paper 1C1046

4765 Surface waves, tides, and sea level
MEASUREMENTS OF THE EQUILIBRIUM RANGE IN OCEAN WAVE SPECTRA
George Z. Forristall (Shell Development Company, P. O. Box 481, Houston, Texas 77001)

Wavestaff measurements made in the Gulf of Mexico and Waverider measurements from the Baltimore Canyon area have been used to study the form of the equilibrium range of ocean wave spectra. The analysis showed that the spectral range between the mean wave frequency and about two and one half times that frequency is consistently proportional to the inverse of the fourth power of the frequency. At higher frequencies [illegible] ... [illegible] reliable specification of the [illegible] of the spectrum when only wind [illegible] available. If the significant wave height and mean period are known, the amplitude of the tail of the spectrum can be predicted with somewhat greater accuracy. However, this relationship should be used with caution when the height and period statistics are influenced by swell.
J. Geophys. Res., Green, Paper 1C0848

4765 Surface waves
ON TSUNAMI NUCLEATION
S. Ward (Harvard University Department of Geological Sciences, 20 Oxford Street, Cambridge, MA 02138)

Near-field tsunami formation is detailed in this paper using point moment tensor sources with a spherically symmetric, self-gravitating and elastic Earth. Snapshots of vertical sea surface motion calculated within 200 km and 100 seconds of an event typically show an initial tsunami pulse slowly grow and then evolve into dispersed wave trains. The direction of first motion, the time and the length scales of the developing pulse contradict static concepts which base tsunami formation on permanent deformations of an otherwise rigid sea floor supporting incompressible water. The permanent strain field at the sea floor is, in fact, irrelevant because it is defined by frequencies well below the range of tsunami interest. Static concepts of tsunami generation are especially misleading if they are applied to sources, such as earthquakes, whose motions are deeply rooted in elasticity theory. The general point moment tensor used here produces frequency dependent tsunami radiation patterns of azimuthal degree ≤ 2. Pure dip and strike slip sources, however, create waves that are symmetric or anti-symmetric about the epicenter. Buried 10 km, with a moment of 10^{20} N-m, these sources generate initial tsunami pulses 40 km wide. Maximum amplitudes of 166 and 45 cm occur 10 km from the epicenter, 60 s after the dislocation. Tsunamis from deeper earthquakes are smaller, broader, and slower to develop because they are depleted of high frequencies.
J. Geophys. Res., Red, Paper 1B0840

4790 Instruments and techniques
SEASAT ALTIMETER HEIGHT CALIBRATION
R. Kolenkiewicz (National Aeronautics and Space Administration, Goddard Space Flight Center, Greenbelt, MD 20771) C.F. Martin

The Seasat altimeter has been calibrated for height bias using four overflight passes of Bermuda which were supported by the Bermuda laser. The altimeter data was corrected for: tides, using recorded tide guage data; propagation effects, using meteorological data taken around the time of each pass; acceleration lag; and sea state bias, including both surface effects and instrumental effects. Altimeter data for each of the four passes was smoothed and extrapolated across the island. Interpolation between passes then produced an equivalent altimeter measurement to the geoid at the laser site, so that the altimeter bias could be estimated without the use of a geoid model. The estimated height bias was 0.0 ± 0.07 m.
J. Geophys. Res., Red, Paper 1B1012

4790 Instruments and techniques
A NOTE [illegible] CONTINUITY TO EXTEND HF RADAR [illegible] MEASUREMENTS S. [illegible]
[illegible] use of the equation [illegible] the HF radar surface current measurements across the baseline of two radars and in regions where only single radar coverage is available.
J. Geophys. [illegible] Paper 1C0869

Editorial

Students Wanted

To advance the scientific study of the earth and its environment in space is the first and primary purpose of the American Geophysical Union. In support of this purpose, one of the working goals of the AGU is to attract competent individual students and research workers to devote their attention to geophysics, and another is to stimulate high quality education for students interested in geophysics. Only by attracting new minds to address old problems and thus uncover new questions can we assure the health of our science. Many of our subdisciplines are having difficulty holding good students through their Ph.D.s because of the attractive opportunities available to them outside the research community. This is challenge we must pick up—not just to fill our ranks, but to fill them with the cream of the upcoming generation.

Geophysics is by nature a focus of various disciplines on problems, and thus it has an inherent problem in capturing the attention of students at the undergraduate level. There are tremendous opportunities for promising physics, chemistry, and mathematics majors who are totally unaware of the exciting direction their education and career could take. To assist you in identifying opportunities that could be passed on to undergraduates in your institution, *Eos* has begun carrying announcements of predoctoral scholarships, fellowships, and graduate assistantships without charge in the classified advertising section. The addition of these student positions expands the popular marketplace for jobs in the earth and space sciences that *Eos* has become. Many of these advertisements will be directed primarily to undergraduate students. Since *Eos* does not have a large circulation to undergraduates, success will depend on the information in this section being passed on by faculty advisors. You may want to copy these notices as they appear or post them or forward them to colleagues in other departments.

The inclusion of these announcements will be one in a series of efforts to encourage good undergraduate students to pursue careers in geophysics. It is being guided by the Committee on Education and Human Resources, with strong support from the Oceanography Section in particular.

To use this new service, send your announcement of available student positions to *Eos*, Classified Advertising, American Geophysical Union, 2000 Florida Avenue, N.W., Washington, D.C. 20009. There will be no charge for the first insertion of such announcements so long as they are 20 lines or less. Subsequent insertions, if desired, will be run at half the regular classified advertising rate.

If you do place an announcement, please help to improve the service by evaluating its impact. Send me your evaluation with your thoughts on other ways to assure that we can do an even better job of attracting and holding good students in geophysics.

Fred Spilhaus

Continental Rifting: Progress and Outlook

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P. Morgan
Lunar and Planetary Institute
Houston, Texas

Increased research activity on continental rifts has led to a flood of new data in the last 15 years, but there is little consensus about the basic mechanisms and causes of rifting. The well-known association of taphrogenic features—doming, faulting, and volcanism—is widely regarded as the result of asthenosphere convection and lithosphere thinning. This concept is supported by observations of long-wavelength negative Bouguer anomalies, and of subnormal P_n velocities in the upper mantle, resulting from convective mass and heat transfer into the base of the lithosphere. Doming, and in some instances faulting, is the result of isostatic adjustment to the resulting expansion. The crust of rifts is abnormally thin (70–80% of normal) and contains high-density rocks assumed to be primarily intrusive basic igneous rocks. The collapse of rift floors may be the consequence of stress-induced lateral extension in the upper crust, possibly assisted by a mass excess of mafic intrusions in the rifted crust. Anomalous electrical conductivity (low) and heat flow (high) are the result of heating and magmatic and hydrothermal activity.

Sengör and Burke [1978] have distinguished two basic modes of rifting: active rifting, in which the lithosphere is cracked by asthenospheric upwelling, and passive rifting, in which a preliminary cracking of the lithosphere occurs because of differential stresses resulting from the interactions of lithospheric plates. A variety of data sets have been interpreted to produce cross sections of the major Cenozoic continental rifts, examples of which are shown in Figure 1. Basic similarities in these cross sections mask subtle structural and evolutionary differences between the rifts, however, and tell nothing of the processes of lithospheric thinning. It is not clear to what extent the anomalous lithospheric structure is a response, as opposed to a cause, of rifting. In a recent volume of papers on the mechanisms of graben formation [*Illies*, 1981], both active and passive modes of rifting are discussed, the former mode primarily in connection with the East African rift system and the latter with reference to the Rhinegraben. The remarkable similarities in rift cross sections (Figure 1) suggest that the anomalous lithospheric structure of rifts is more dependent on lithosphere properties than the mode of rifting.

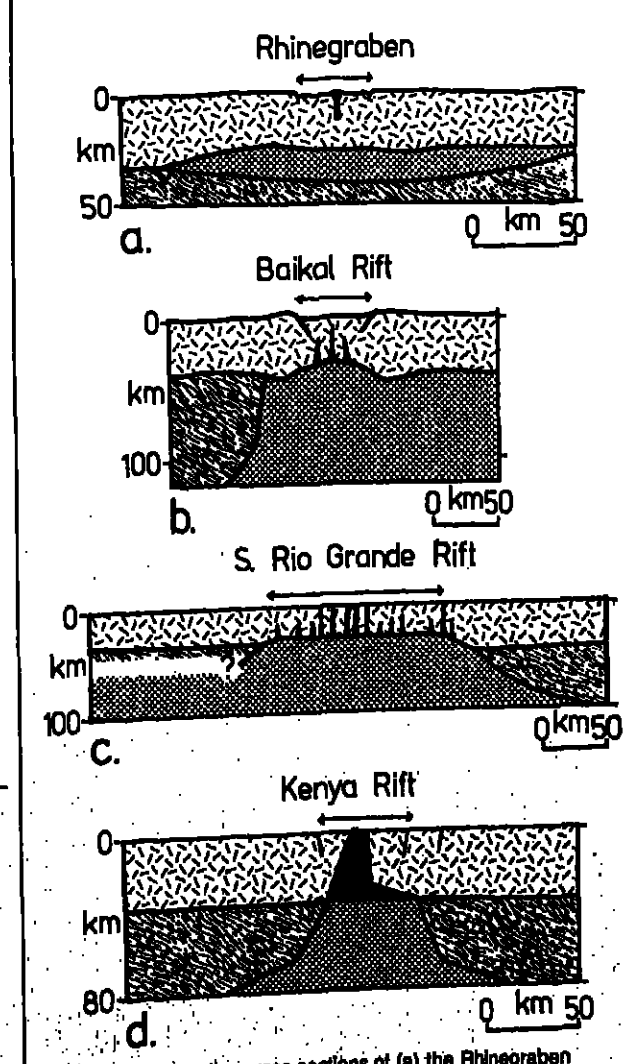

Fig. 1. Interpretive cross sections of (a) the Rhinegraben [adapted from *Prodehl* et al., 1976]; (b) the Baikal rift [adapted from *Zorin*, 1981]; (c) the southern Rio Grande rift [adapted from *Seager and Morgan*, 1979]; and (d) the Kenya rift [adapted from *Baker and Wohlenberg*, 1971], based on a variety of data sets. Key: straight line pattern—crust; wavy line pattern—lithosphere or 'normal' upper mantle; stipple pattern—asthenosphere or 'anomalous' upper mantle; solid black pattern—basic crustal intrusions.

It is clear that continental rifts are diverse and may form by a variety of processes. Some paleorifts on continental margins are regarded as 'failed arms' of spreading axes, and the East African rift may be a modern example of this type. Others are spatially and temporally connected with collision orogeny (Rhine; Baikal), and some appear to be intraplate structures with no clear relation to other tectonic features (Oslo; mid-continent U.S.). Special categories are needed for rifts in complex tectonic settings such as the Basin and Range of the western U.S., which may be an expression of back-arc spreading related to subduction, locally modified by the stresses imparted by the San Andreas transform fault. The Snake River-Yellowstone zone is a grabenlike feature, an elongated depression associated with little or no extension, and could represent a 'hot-spot' trace.

Viewed in this fashion it seems that there is a spectrum of rifting processes for which two fundamental mechanisms can be postulated, similar to the two modes of rifting distinguished by *Sengör and Burke* [1978]: an *active* mechanism whereby thermal energy is transmitted into the lithosphere from the underlying asthenosphere, and a *passive* mechanism by which mechanical energy is transmitted laterally through the lithosphere as a consequence of plate interactions at a distance. There may also be combinations of these two mechanisms. In order to allow the concept of the two fundamentally different mechanisms to be tested, we propose a tentative classification that divides rifts into the two basic categories:

Active Rifting:

(1) Rift systems connected to midocean ridges and representing lateral extension as a result of asthenospheric convection. Structure is superimposed across older structures and has strong volcanism (e.g., East African rift system);
(2) Smaller-scale rift zones generated by 'plumes' or 'hot-spots,' with little or no regional extension. Localized domes are formed by volcanism, with a trail of inactive troughs and grabens (e.g., Snake River-Yellowstone zone);
(3) Back-arc fault zones and grabens (e.g., Basin and Range, grabens of the Andes);

Passive Rifting:

(1) Rifts associated with continental collision orogeny and formed by wedging and splitting of the lithosphere. The location and orientation is strongly influenced by preexisting structures, there is little igneous activity, and strike-slip motion may be locally important (e.g., Rhine-Rhone and Baikal rifts);
(2) Rifts associated with large strike-slip boundaries and resulting from the transmittal of shear stresses from the boundaries (e.g., western Turkey, Basin and Range).

The magnitude of active rifting will depend on the rate at which lithosphere moves over the thermal source, with rifts being restricted to stationary or slow-moving plates [e.g., see *Burke and Wilson*, 1972]. No such restriction applies to passive rifting, since the lithosphere thins in response to extension, and the source stresses are transmitted in the moving lithosphere plate. Other distinctions between the two mechanisms are in the influence of prerift structural elements, which should be strong for passive rifting and weak for active rifting. *Sengör and Burke* [1978] give different sequences of events for the two modes of rifting: the active mechanism predicts doming-volcanism-rifting, the passive mechanism rifting-(uplift?)-volcanism. For active rifting the magnitude of uplift and volume of igneous rocks should be much larger than for passive rifting, and a difference in igneous character may result: active—weakly alkaline to tholeiitic; passive—strongly alkaline (?).

Data relevant to the understanding of the processes are not restricted to the earth. For 'one-plate' planets such as Mars, the processes of rifting are possibly easier to decipher, and the mechanisms can be applied to some rifts on Earth. The great Martian rift, Valles Marineris, is easily modeled in terms of the stress field imparted by the topography and the gravity field (Figure 2) [*Phillips and Lambeck*, 1980]. The modeling results strongly suggest that the rift *followed* the formation of the Tharsis Plateau. Rifts are also found on Venus, a planet that ought to be as thermally active as the earth but appears to lack contemporary terrestri-

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Cover. Photograph shows the MST (mesosphere, stratosphere, troposphere) radar at Poker Flat, Alaska. This NSF-funded project was developed by the Aeronomy Laboratory of the National Oceanic and Atmospheric Administration to investigate atmospheric dynamics in the height range 2–100 km. The coherent (Doppler) radar system operates continuously to obtain data on winds, waves, turbulence, and atmospheric stability. System parameters for the completed system include a peak transmitted power of 8 MW and an antenna area of 4 × 10^4 m^2. As seen in this photograph, the 64 transmitter modules are contained in separate housings in the antenna array. The antenna is currently connected in a three-beam configuration (vertical, off-vertical to the east and to the north). Although completion is not scheduled until the end of 1981, a portion of the system, operating at a lower sensitivity, has been in essentially continuous operation since February 1979. The building complex at the top of the photograph is the Poker Flat Rocket Research Range operated by the University of Alaska. (Photo taken by Paul E. Johnston and submitted by Ben B. Balsley, both of the Aeronomy Lab, NOAA, Boulder, Colo.)

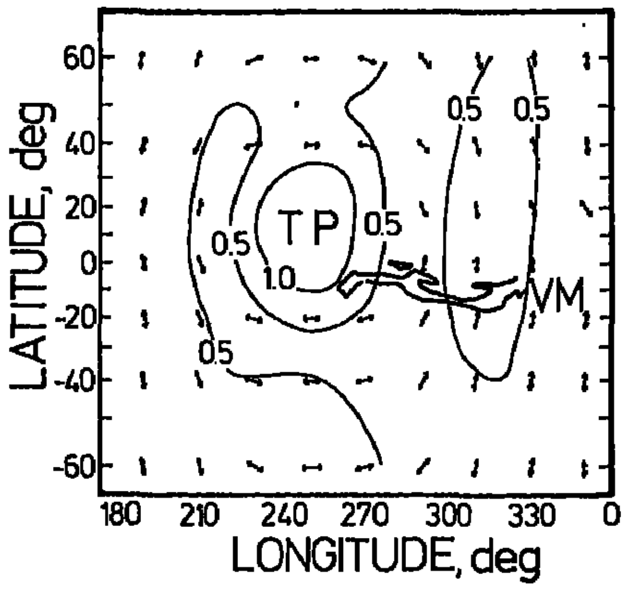

Fig. 2. Magnitude and direction of the theoretical horizontal tensile (principal) deviatoric stresses at the surface of the Tharsis Plateau (TP), Mars, imparted by the topography and the gravity field. Contours are magnitude of maximum stress, in kilobars. Note the orthogonal relationship between the Valles Marineris (VM) and the stresses. [Adapted from *Phillips and Lambeck*, 1980].

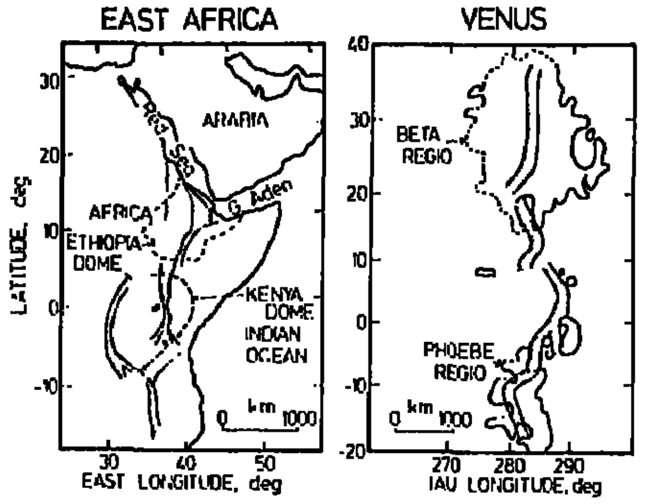

Fig. 3. Comparison between the East African rift system (cutting across the Ethiopia Dome and the Kenya Dome) and the major Venus rift system (cutting across the highlands of Beta Regio and Phoebe Regio). Depressions are indicated by the stipple pattern. (From George McGill, Univ. of Massachusetts, personal communication, 1981).

al-style plate tectonics. Analogies have been made between the Venus rifts and the East African rift system (Figure 3), but the role of rifts in the tectonics of Venus is poorly understood at this time.

Hydrocarbon, mineral, and geothermal resources associated with rifting give an additional economic value to rift studies. Ideally models should predict the evolution of these resources. The diversity of rifts makes this a complex problem, however. In order to obtain a better understanding of rift processes and to apply adequate constraints to models, multidisciplinary studies of active rifts are needed to describe their evolution and to allow alternative mechanisms to be formulated and tested.

This problem and others will be addressed at a conference on the 'Processes of Planetary Rifting,' to be held December 3–5, 1981, at the Christian Brothers' Retreat House in the Napa Valley, California, immediately prior to the fall Annual Meeting of the American Geophysical Union (in San Francisco). Persons interested in attending the rift meeting should contact the Projects Office, Lunar and Planetary Institute, 3303 Nasa Road One, Houston, Texas 77058 or call (713) 486-2150 for further information.

Acknowledgment

We thank R. J. Phillips for input and criticism of this manuscript.

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Forum

Flinn's Feature Fuels Forum

The entertaining note by Edward A. Flinn (Information transfer in verbal presentations at scientific meetings, *Eos, 62*, 179, 1981) brought to mind a somewhat similar discussion of this problem by the Scottish physicist, James Clerk Maxwell (1831–1879). Evidently, in response to a query from *Professor Guthrie about the role of a physical society*, which was something like an AGU meeting, he wrote in 1873 to W. G. Adams [*Campbell and Garnett*, 1884; p. 294]:

> For the evolution of science by societies the main requisite is the perfect freedom of communication between each member and any one of the others who may act as a reagent.
> The gaseous condition is exemplified in the soiree, where the members rush about confusedly, and the only communication is during a collision, which in *some instances may be prolonged by buttonholing*.
> The opposite condition, the crystalline, is shown in the lecture, where members sit in rows, while science flows in an interrupted stream from a source which we take as the origin. This is radiation of science.
> Conduction takes place along a series of members seated round a dinner table, and fixed there for several hours, with flowers in the middle to prevent cross currents.
> The condition most favourable to life is an intermediate plastic or colloidal condition where the order of business is (1) Greetings and confused talk; (2) A short communication from one who has something to say and to show; (3) Remarks on the communication addressed to the Chair, introducing matters irrelevant to the communication but interesting to the members; (4) This lets each member see who is interested in his special hobby, and who is likely to help him; and leads to (5) Confused conversation and examination of the objects on the table.

This pretty much describes an AGU meeting. Sleep is not explicitly mentioned, but it certainly occurs when (2) is not met, whereupon (3) flourishes, (4) is blatantly satisfied, and (5) follows.

It is interesting, if not somewhat surprising, that even though our language has changed a great deal in 100 years, our problems have not.

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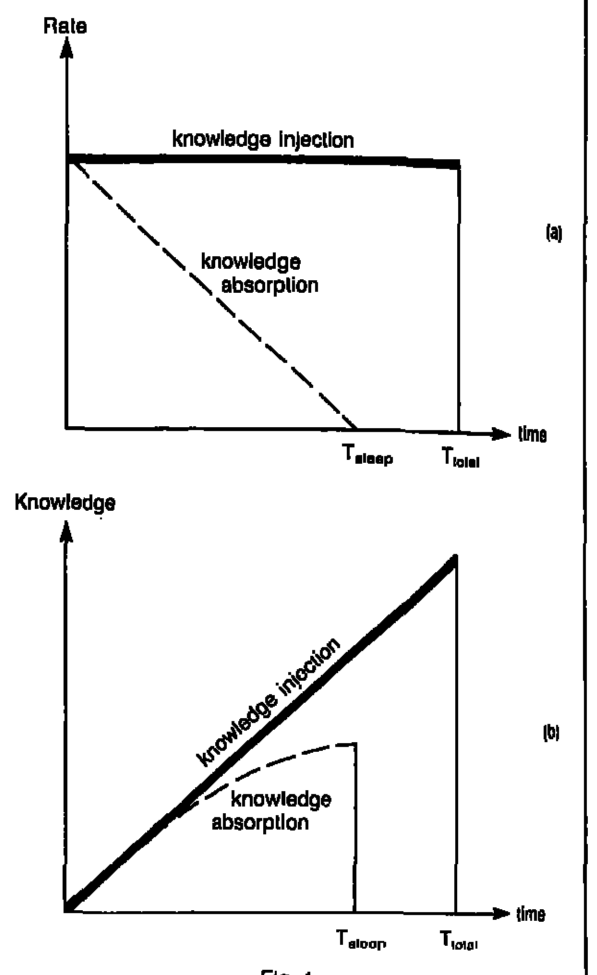

Fig. 1.

Flinn's AVT curve can be obtained only if the audience attention factor is applied directly to the integrated knowledge injection. That operation represents a model in which, as sleep approaches, the audience loses any knowledge it had gained earlier. Given that model, which may have some validity, the speaker is indeed best cut off at T_{max}, when AVT is a maximum. Note, however, that in that case the AVT curve (not its integral) represents the knowledge absorption.

Richard Greenberg
Nit Picker
Planetary Science Institute
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In his article, 'Information Transfer in Verbal Presentations at Scientific Meetings' (*Eos, 62*, 179, 1981), E. A. Flinn raises some important issues. Unfortunately, the mathematical model is somewhat muddled. The internal inconsistency of the analysis became evident when I considered the conclusion that program chairpersons should stop the speaker at T_{max}. It is understandable that a former AGU annual meeting chairman should advocate such a time-conserving approach, but Flinn's own Figure 1 shows the knowledge absorption curve at a maximum slope at T_{max}. In other words, he advocates cutting the speaker off just as the audience is absorbing knowledge at a maximum rate. Surely the optimum cutoff time would be later.

The AVT is defined as the *rate* of knowledge absorption, so its decrease after T_{max} does not imply that T_{max} is the 'point of diminishing returns.' The author's confusion at this point in the discussion is related to earlier ambiguity as to which quantities are rates and which are integrated amounts of knowledge. This problem would likely have been avoided if the basic rule of graphic presentation had been followed: 'LABEL ALL AXES.'

Suppose we rework the analysis, paying closer attention to the distinction between rates and integrated knowledge (Figure 1). 'Knowledge injection' is at a constant rate (at least in Flinn's model). The audience attention factor goes linearly from 1 at $t = 0$ to 0 at $t = T_{sleep}$, so the knowledge absorption rate drops linearly as shown in Figure 1*a*. Knowledge absorption is the integral of that rate, the quadratic shown in Figure 1*b*. This result is nothing like the curve shown by Flinn.

Regarding Edward A. Flinn's discussion on information transfer in verbal presentations at scientific meetings (*Eos, 62*, 179, 1981), *it occurred to me that a similar theoretical* approach could be developed concerning (1) the effect of consecutive talks on an audience and (2) duration (number of days) meetings should be. Factors which have to be considered for (1) are *(a)* times when talks are given (low-priority talks being assigned to times early in mornings, late in evenings, or on the last day of a meeting), *(b)* the impact of coffee breaks, beer sessions, and jet lag on both speakers and audience (a different function for jet lag will exist for East and West Coast meetings), and *(c)* the effect of competitive sessions scheduled simultaneously at opposite ends of the conference center, or even, as commonly occurs, in different buildings. Regarding (2), external factors come into play such as *(a)* has the conferee brought his/her family along? *(b)* median travel and per diem allowances surviving in proposals (an indirection function of national election results), and *(c)* the quality of local night life. Finally, Flinn devotes no attention to speaker strategies to maximize rate of knowledge injection. This can be done in two ways. The first is to vary the rate of knowledge injection at different points in the talk, and the second is to extend audience attention by interjection of humor, use of attractive slides, or causing excessive audio feedback with the microphone. The objective is to make the integrated AVT function more closely approach the integrated audience attention function.

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Staff Scientist
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News

Low-Gravity Materials Processing

The concept of growing crystals and of doing biological studies in the low-gravity space environment assumes that the absence of most, or all, of the influences of the earth's gravitational field on chemical and biological reactions is an important factor—at least important enough to justify costly testing.

One normally thinks of the effects of the gravitational field as being like the effects of any other field, electric or magnetic, on a thermodynamic process. In the simplest terms, there is work done as parts of a system travel through a gravitational field; a more exact statement would be that the free energy of a system, and hence the state of equilibrium, depends on the position within a gravitational field. The thermodynamic effects of the earth's gravitational field (the equation for the changes in free energy caused by differences in position within the field) are subtle but could be important in chemical and biological processes.

One of the new technologies that has emerged from the space program is the practical processing of materials in an environment where the effects of gravity are greatly reduced or eliminated. Early work done in the field has shown that low gravity eliminates, or greatly reduces, the effects of buoyancy, sedimentation, and convection on materials processes.

A technical exchange agreement—the first of its kind—has been signed between NASA and Deere and Company, Moline, Ill., to study the effects of low gravity on various iron alloys. Under the agreement, NASA's Marshall Space Flight Center, Huntsville, Ala., will use low-g facilities available to it—including *drop tubes, KC-135 and F-104 aircraft*, and possibly sounding rockets—to substantially reduce gravity conditions during alloy solidification experiments. Deere and Company will do sample preparation, ground-based characterization of the sample, extensive sample analyses, and data reduction, as well as thermal characterization of the furnace used for melting and solidifying the samples. The experiments and investigations performed under the agreement could eventually lead to Deere conducting research aboard a future space shuttle mission.

Data will be shared between the two parties. NASA and Deere personnel will visit each other's facilities and participate *in experiment planning and analyses. The agreement* is expected to be in effect for 1 year, but it may be extended if needed.

NASA currently is carrying out low-g processing in such areas as alloy solidification, crystal growth, biological separations, and chemical and fluid physics. NASA's Materials Processing in Space program has developed a variety of ground-based and flight facilities and experiment hardware to utilize the low-gravity environment and has invited industry to participate in joint investigations and projects.

In this concept for involving industry, the federal government and a private company agree to be responsible for specific portions of the research effort, and no funds are transferred between parties. The allocation of rights to resulting inventions and data is subject to negotiation between the parties for each effort undertaken.—*PMB*

WINDSAT: Space Wind Sensor to be Tested

A new wind sensor system is being tested on a mesa north of Boulder, Colo., by a team led by Freeman Hall of the Wave Propagation Laboratory. If the tests are successful, a more advanced version of the system may be tried out late in this *decade on the Space Shuttle. The system's* ultimate destiny would be aboard a proposed satellite called WINDSAT.

Global wind measurements are a vital but missing link in efforts to improve long-range weather forecasting. Present upper-air wind measurements, mostly by instrumented balloons, are too limited, and there is a need for an extended method.

The new wind sensing system is built around a laser radar that can gauge the speed with which winds are moving toward or away from it. Measurements come from the frequency shift of infrared beams reflected from wind-borne particles.

The system envisioned for WINDSAT would be able to measure the winds in layers spaced 1 km apart. The present version, in which the laser beam is projected by a mirror 25 cm in diameter, has a range of 20 km. The satellite version would have a mirror 1¼ m in diameter and would be powerful enough to scan hundreds of kilometers. [Source: NOAA]

B.S. in P.E. = $30K/Year

Earth sciences graduates can '... [look] forward to long lines of would-be employers who will try to tempt [them] with high salaries,' according to a report describing a new survey by the College Placement Council (*Industrial Research and Development*, July 1981). This survey of the job market reports that graduates with the bachelor's degree in the earth and physical sciences have been starting employment at an average salary of approximately $22,000 per year. This figure amounts to an 18% increase over the average starting salary for the same groups a year ago.

Another important result is that some starting salaries for petroleum engineers (B.S. in P.E.) are upward of $30,000 per year, which though not at all unusual, was the top starting salary group for 1981 college graduates. *Industrial Research and Development* points out that liberal arts graduates consider themselves to be fortunate if offered starting salaries of $12,000 per year.

Petroleum engineers, and engineers in general, traditionally get the best offers; the increase in earth scientists' salaries is a notable exception this year. Many other fields are oversubscribed and overemployed. An example of a field that is now and has been in the *past highly popular among* employees is the field of computer science. The average starting salary this spring for computer majors was approximately $20,000 per year, but this level constituted only a relatively small increase over last year's starting salary.

As a group, engineers simply do better than any other group right out of college. As quoted from the College Placement Council's report (Spring, 1981), "63% of all the job offers at 161 colleges and universities surveyed by the Council went to engineers." Note though that the engineering majors from those universities made up only about 7% of the graduates.

Nation's Water Picture Brightens

The nation's streams took a strong upturn during June, showing good recovery from the persistent dry trend of the previous months, although scattered pockets of below-normal flow were reported in parts of the Southeast and the West, according to a month-end check by the U.S. Geological Survey.

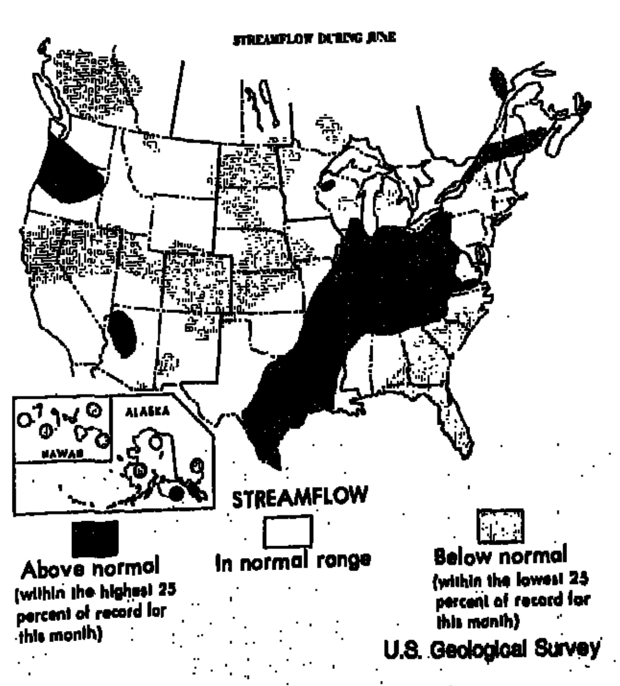
USGS hydrologists said that 30% of the 165 key index stations reporting across the country in June showed well-below normal streamflow (within the lowest 25% of record), a decided upward trend from May, when half of the index stations reported below-normal streamflow. Below-normal flows were reported in parts of 27 states during June, down from the 31 states that reported low flows in May.

The Southeast is, however, still severely affected by the long months of dry conditions. A band of persistent low flow exists from the Carolinas south to Florida and west through Georgia and Alabama. Flows on some streams in South Carolina have been in the lowest 25% of record now for six straight months. That is, 75% of the time, streamflow will be equaled or exceeded. All six of the key index stations in Florida reported below normal flows for June, the second *consecutive month that all six stations have been below* normal.

Strong recovery was noted from the Great Lakes Region south through Kentucky, Tennessee, Arkansas, and most of eastern Texas, where streamflow was within the highest 25% of record for June.

Reflecting the general national improvement in June streamflow conditions, combined flow of the "Big Five" rivers (Mississippi, Columbia, St. Lawrence, Ohio, and Missouri) averaged 1261 billion gallons a day (bgd), 30% above normal and the first time in 7 months that the combined flow of the rivers has been above normal.

* Individual flows of the Big Five for June: Mississippi River near Vicksburg, Miss., 573 bgd, 50% above normal and a 48% increase from May; Columbia River at The Dalles, Ore., 302 bgd, 2% below normal but 20% above last month; St. Lawrence River near Massena, N.Y., 164 bgd, 3% below normal but 2% above last month; Ohio River at Louisville, Ky., 147 bgd, 270% above normal and 32% above May; and the Missouri River at Hermann, Mo., 75 bgd, 6% above normal and 8% above May. (Photo credit: U.S. Geological Survey, Department of the Interior.)



Keyworth Reflects Reagan Policy

George Keyworth, new presidential science advisor, revealed what may be the elements of a new approach to the support of scientific research in the United States. Keyworth gave his first major address at the recent Research and Development Policy Seminar held in Washington under the sponsorship of the American Association for the Advancement of Science (AAAS). The United States must be prepared to relinquish its leadership position in some areas of scientific research, he stated. The U.S. will focus its science toward assuring that the country is second to none in military might.

Keyworth stressed that the Administration's proposed budget provides funding needed for support of the "hard" sciences. He made the point that this country can no longer afford to maintain a leadership role in the broad spectrum of sciences, but instead must be selective. He appeared to divide the federal government's future funding support in *science between the areas of pertinent and promising science* and the disciplines that support technology, both industrial and military. The "pertinence" was in relation to prevailing national requirements. The "promise" was in reference to his conviction that the "payoff" of basic research could not be expected for upwards of 10 years after a grant had been awarded.

Like his predecessor in the directorship of the Office of Science and Technology Policy, Keyworth sees his role not so much as an advocate of the sciences, who has the President's ear, but as more of an advisor, a setter of priorities.

Although the main thrust of Keyworth's speech was that the country's preeminence in scientific research was to be restricted to areas of science selected after careful review, he did not indicate support of any standard less than one of excellence. Some fields would simply have to be abandoned, but those supported would have to be of convincingly high priority. He gave the widely held opinion that pumping more and more funds into an area of research, even one of high priority, is a process that succumbs, eventually, to the law of diminishing returns. Support, therefore, is to be granted to essential programs, and even then, to a limited level.—*PMB*

Geophysicist Obituary

J. M. Burgers, 86, died on June 7. He joined AGU in 1956.

New Publications

Weather Modification by Cloud Seeding

A. S. Dennis, Academic, New York, xv + 267 pp., 1980, $29.50.

Reviewed by Charles L. Hosler

This book accomplishes its stated purpose of providing information on cloud seeding to upperclassmen or graduates of university programs in the physical sciences or engineering, and I would recommend it to them as a quick and painless way to become conversant with what cloud *seeding* is all about. *The book may discourage an even* larger audience of nontechnically oriented cloud-seeding enthusiasts or seekers of knowledge by the omission of a paragraph or two of a more elementary and descriptive treatment of processes such as nucleation, cloud formation, and precipitation formation at the beginning of the chapters treating those topics. The nine chapters cover an introduction, which includes a brief history and context for cloud seeding; 'Atmospheric Aerosol'; 'Formation of Clouds and Precipitation'; 'Concepts and Models for Cloud Modification'; 'Generation and Application of Silver Iodide Crystals and Other Seeding Agents'; Statistical Evaluation of the Results of Cloud Seeding'; 'The Modification of Fog, Snow, and Rain'; 'Suppression of Weather Hazards'; and 'Impacts of Weather Modification on Society.' All of these chapters are brief and to the point. The elaboration that many of those familiar with the topics treated might seek or feel necessary for completeness would have turned the book into something the author did not intend it to be.

The readers seeking a quick answer as to whether or not cloud seeding is the answer to their concern in a situation where they need rain or want to prevent or promote some weather event will be disappointed. There is no formula to apply or table or graph that will help to decide. This is as it should be because the answers are not that easy to deter*mine, even by the experts. The reader seeking that infor*mation will probably conclude that he needs expert advice and that also is as it should be. The general physical knowledge and the information on the potential for weather modification through cloud seeding available in this book will place the person seeking advice in a position to at least ask the right questions.

There is a persistent tendency on the part of nonmeteorologists, supported by some early claims by cloud seeders, to presume that weather over the whole country or even global weather can be altered by local or regional seeding. Thus, the reviewer would have preferred a stronger case be made for the lack of a physical basis for expecting cloud seeding to affect the overall development of wave cyclones and large-scale synoptic features. The casual reader may miss the brief treatment stating that we have no hypothesis to support this type of modification. This should have been backed up by the reasons one would not expect such modification.

This is a useful book by a knowledgeable author that should find its way onto the bookshelves of college teachers and technically oriented users or potential users of cloud seeding. For those interested in extensive examination of the subject, it is a good starting point.

Charles L. Hosler is with the Department of Meteorology, Penn State University, University Park, Pennsylvania.

Geodesy

W. Torge, Walter de Gruyter, New York, xi + 254 pp., 1980, DM 48.

Reviewed by K. P. Schwarz

The book is a translation of a well-known German textbook on geodesy, which has been widely used since its publication in 1975. On occasion of this translation it has been revised and thus includes developments to about 1979.

The book is subdivided into the following sections: Introduction, The Gravity Field of the Earth, Geodetic Reference Systems, Methods of Measurement in Geodesy, Global Geodesy, and Geodetic Surveying.

The introductory section reviews briefly the definition, historical development, and organizational structure of geodesy. The second section discusses the components of the gravity potential, level surfaces, and plumb lines, the representation of the geopotential by spherical harmonics, and time variations of the gravity field. The third section introduces global and local astronomic and terrestrial frames and relates them to the reference surfaces defined by the actual and the normal gravity field. The fourth section treats astronomic, satellite, and terrestrial positioning methods as well as the measurement of absolute and relative gravity. The fifth section deals with the problem of determining a global representation of the gravity field by astrogeodetic, gravimetric, satellite, or combination methods and discusses some implications for the structure and dynamics of the earth. The last section, somewhat of a misnomer, gives an introduction into horizontal, vertical, and gravity networks.

The strength of Torge's *Geodesy* is its conciseness and good organization. The whole material is presented on 254 pages with sections 4 and 5 taking about two thirds of the space. The price for this conciseness is the absence of detailed derivations. In general, only major steps in the development are given, and often one has to be content with the final formula. The author has added, however, an extensive bibliography and has cross referenced the text with great care. The interested reader can thus go back to source information, although a knowledge of German besides English is mandatory in this case. The presentation shows a good balance between the mathematical formulation of a problem and its descriptive explanation and thus provides the reader with a clear picture of the fundamentals and the techniques presently used in geodesy.

In summary, the book presents the body of geodetic knowledge in a well-organized form and formulates the main problems and solution approaches in a concise and careful manner. It is therefore welcome in a field where good textbooks do not abound. It is recommended as an undergraduate text for geodesy courses but will also serve the geoscientist who wants an up-to-date presentation of the field without a detailed discussion of current research problems.

The excellent quality of printing and graphics reproduction as well as the smooth translation of the original text add to the attractiveness of the book.

K. P. Schwarz is with the Division of Surveying Engineering, University of Calgary, Calgary, Alberta, Canada.

New Listings

Items listed in New Publications can be ordered directly from the publisher; they are not available through AGU.

Space Science Comes of Age: Perspectives in the History of the Space Sciences, P. A. Hanle, V. D. Chamberlain (Eds.), Smithsonian Institution Press, Washington, D.C., xiii + 194 pp., 1981, $12.50 (paper), $22.50 (cloth).

Statistical Treatment of Environmental Isotope Data in Precipitation, Tech. Rep. Ser. 206, International Atomic Energy Agency, Vienna, Austria, xx + 255 pp., 1981.

The Economics of Irrigation, I. Carruthers and C. Clark, Liverpool University Press, Liverpool, England, xviii + 300 pp., 1981, £20.00.

The Inaccessible Earth, G. C. Brown and A. E. Mussett, Allen & Unwin Inc., Winchester, Massachusetts, xii + 235 pp., 1981, $41.00 (cloth), $22.50 (paper).

The Magnetotelluric Sounding Method, A. A. Kaufman and G. V. Keller (Eds.), Elsevier, New York, xiv + 596 pp., 1981, $144.00.

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EOS offers classified space for Positions Available, Positions Wanted, and Services, Supplies, Courses, and Announcements. There are no discounts or commissions on classified ads. Any type that is not publisher's choice is charged for at display rates. EOS is published weekly on Tuesday. Ads must be received in writing on Monday 1 week prior to the date of the issue required.

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Visiting Scientist Position/The Joint Institute for the Study of the Atmosphere and Ocean, University of Washington. Visiting scientists with background in atmospheric sciences or physical oceanography and interests in dynamical and or geochemical aspects of climate variability. Term of appointment: one (1) year, renewable for a second year subject to the approval of the Council. Closing date: September 15, 1981. Send curriculum vitae and a brief research prospectus to Director, JISAO, c/o Department of Atmospheric Sciences, AK-40, University of Washington, Seattle, WA 98195.

An equal opportunity/affirmative action employer.

Atmospheric Scientist/Group Head. Senior staff scientist position available immediately at the NAIC's Arecibo Observatory. The successful applicant will be appointed as Head of the Atmospheric Sciences Group and will be expected to lead that group and to perform independent research using the Arecibo facilities. A Ph.D. degree in atmospheric or physical sciences or radar engineering and a record of solid research accomplishments are required. Experience with radar studies of the stratosphere, mesosphere, and ionosphere or with HF modifications of the ionosphere is desirable. Salary open. Please send resume and names of at least three references to Dr. Harold D. Craft, Jr., Director, Arecibo Observatory, Space Sciences Building, Cornell University, Ithaca, New York 14853.

NAIC/Cornell University are EOE/AAE.

Physical Oceanographer. A postdoctoral research position in physical oceanography is available at the University of North Carolina at Chapel Hill, to begin as early as August 1981. Ph.D.'s with background and interests in mesoscale Gulf Stream dynamics, geophysical fluid dynamics, or ocean acoustics are encouraged to apply. Initial appointment will be for one year with a possible continuation through a maximum of three years. Please send vitae and the names of three references to Professor John M. Bane, Marine Sciences Program, 12-5 Venable Hall 045A, University of North Carolina, Chapel Hill, North Carolina 27514.

The University of North Carolina is an affirmative action/equal opportunity employer.

University of Hawaii/Faculty Positions. The Department of Geology and Geophysics and the Hawaii Institute of Geophysics have openings for the 1981–1982 academic year. Rank is open dependent on qualifications. We are seeking persons who will participate in our teaching and research program in any of the following areas: (1) structural geology and marine tectonics; (2) hydrology and engineering geology; (3) marine seismology, magnetics, and gravity. To apply send a letter of interest, a current vita and 3 letters of reference to Dr. S. O. Schlanger, Chairman, Department of Geology and Geophysics, University of Hawaii, 2525 Correa Road, Honolulu, Hawaii 96822 (808-948-7826), or Dr. C. E. Helsley, Director, Hawaii Institute of Geophysics, same address (808-948-8760). Open until filled.

The University of Hawaii is an affirmative action and equal opportunity employer.

Research Associate in Physical Oceanography. Applications invited for a 12 month position as Research Associate in the School of Oceanography, Oregon State University. Ph.D. in physical sciences. Must have demonstrated ability to analyze oceanographic data, preferably data from small-scale turbulence experiments.

Appointee will be expected to cooperate in the analysis of oceanic microstructure data. Salary: $22,000. Submit application and names of three references by 31 August 1981 to:

Douglas R. Caldwell
School of Oceanography
Oregon State University
Corvallis, Oregon 97331

OSU is an affirmative action/equal opportunity employer.

Polar Oceanographer/Sea Ice Dynamicist. A position is available under the Intergovernmental Personnel Act of 1970 for persons now employed in State/local government or in colleges and universities. This position is located within the Oceanic Processes Branch of the Environmental Observation Division of the Office of Space and Terrestrial Applications, NASA Headquarters. The position is for one year, with the possibility for renewal for an additional year. Pay will be at a level commensurate with experience, and will be established after a review of qualifications.

Candidates must have been employed by the university in a permanent position for at least 90 days or be a career employee of a State or local government. Candidates must also meet the Federal qualification standards for the position. These are as follows: a degree in an appropriate field of science, plus three years of progressively responsible experience in duties related to the position.

This individual will be responsible for planning, developing, and implementing a scientific research program in satellite remote sensing of oceanic processes in polar regions. A background in polar oceanography, sea ice dynamics, or a closely-related field is required; experience in remote sensing, although desirable, is not essential. A Ph.D. or equivalent training and experience is mandatory.

Interested parties should send a current resume to NASA Headquarters. Attn: Mrs. Catherine Zegowitz, Code EPM-3, Washington, D.C. 20546.

Selection for this position will be made from otherwise eligible candidates without discrimination for any nonmerit reason such as race, color, religion, sex, national origin, politics, marital status, physical handicap, age, membership or nonmembership in an employee organization, or personal favoritism.

Electron Microprobe Technical Specialist/University of Colorado. The department of Geological Science, University of Colorado, Boulder, seeks a person who will assume responsibility for the department's electron microprobe laboratory. Duties will include day-to-day operation of our MAC 400 microprobe equipped with a KEVEX EDS system, instruction of new operators, maintenance of the microprobe as well as other X-ray equipment within the Department, microprobe software and hardware development, and participation in research projects involving silicate, sulfide and oxide mineralogy. The job requires either a degree in electronic or electrical engineering, or two years of technical experience utilizing electronic instrumentation associated with an electron column instrument. An individual with an M.S. degree in Geology and microprobe experience will be considered highly desirable. Salary ranges from $20,000–$25,000 depending on experience. Please send, by August 15, letter of application and resume to Bruce Badger, Personnel Department, University of Colorado, 1511 University Avenue, Boulder, CO 80309.

The University of Colorado is an equal opportunity/affirmative action employer.

Acoustical Physicist. Physics and Chemistry Department of Naval Postgraduate School (NPS), in Monterey, California, seeks applicants for tenure-track position at assistant or associate professor level, physicist who has experience and interest in teaching and research in area of acoustics. Primary mission of NPS is advanced education of Naval Officers. Department offers M.S. and Ph.D. degrees in Physics and Engineering Acoustics with major emphasis on Master's degree program. Most acoustics teaching is at senior and graduate level with concentration in underwater acoustics. Candidate must have Ph.D., be effective teacher and be interested in and capable of engaging in research. Current acoustics research areas: ocean acoustics including propagation, ambient noise, scattering and diffraction; propagation in tapered wave-guides; acoustic imaging; signal processing and non-linear acoustics. Send resume and references to Prof. O. B. Wilson, Department of Physics and Chemistry, Naval Postgraduate School, Monterey, CA 93940.

Affirmative action/equal opportunity employer.

Geohydrology/Geochemistry/Economic Geology. Applications are invited for a one year appointment effective August 19, 1981 to teach undergraduate courses in introductory geology and either geohydrology, geochemistry, or economic geology. Ph.D. preferred but will consider ABD. The position will be reannounced in September 1981 as a tenure track slot at the assistant professor level with teaching and research duties about 50/50. Applications including resume and names of three references should be sent to W. G. Gosnold, Jr., Department of Geography-Geology, University of Nebraska at Omaha, Omaha NE 68182.

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STUDENT OPPORTUNITIES

Meteorology and Physical Oceanography Assistantships. Research assistantships for graduate students in meteorology and physical oceanography are available from The Florida State University. Research topics may cover atmospheric dynamics, physical meteorology, synoptic meteorology, climatology, numerical weather prediction, physical oceanography, chemical oceanography, ocean modeling, satellite oceanography and geophysical fluid dynamics.

Appointments are half-time and offer salaries up to $10,500 per year. Beginning graduate students may be offered salaries as low as $7,200. Students with undergraduate degrees in physics, chemistry, mathematics, statistics, meteorology, oceanography and engineering are encouraged to apply.

Additional information may be obtained from Dr. James J. O'Brien, Mesoscale Air-Sea Interaction Group, The Florida State University, Tallahassee, Florida, 32306.

AGU

Highlights: Spring Council Meeting

Council members present at the May 24, 1981, meeting were Keiiti Aki, Steven Burges (for Jim Wallis), Peter S. Eagleson, E. R. Engdahl, Charles E. Helsley, James R. Heirtzler, Carl Kisslinger, Leslie H. Meredith, Chris N. K. Mooers, Norman F. Ness, Marcia M. Neugebauer, James J. O'Brien, Richard Rapp, Carl Sagan, James C. Savage, Joseph V. Smith, Fred Spilhaus, Donald L. Turcotte, James A. Van Allen, J. Tuzo Wilson, and Jay Winston (for Elmer R. Reiter until his arrival at 6:50 P.M.). David Strangway, representing the Canadian Geophysical Union, and Peter Steinhauser, representing the European Geophysical Society, were special observers at the meeting. Council meetings are open, and a number of section secretaries, committee chairmen, journal editors, and other members attended. The following major actions were adopted by the Council:

The experiment of publishing oceanography and lower atmosphere papers in JGR Green issues alternate to those containing upper-atmosphere papers will be continued through 1982. From preliminary indications the experiment seems to be working, but a full year of data, including a renewal cycle, is needed to assess the success of the experiment. Final decision will be made prior to the 1983 dues notices.

Publication of a bimonthly journal devoted to tectonics will begin in 1982. Because there will be no page charges, the journal will be strictly limited as to the number of pages published annually. Printing will be from author-supplied copy. The outline of this proposal was given in the editorial column of the April 7 issue of *Eos*.

The AGU Congressional Science Fellowship was continued for 1982–1983. In discussion of this issue it was noted that congressional staffing tends not to include scientists, and therefore science is not represented in the congressional committees. AGU participates in the AAAS Congressional Fellows Program.

Participation in the AGI (American Geological Institute) Minority Scholarship Program was continued through the 1982–1983 school year. The program has attracted many good applicants. Applicants funded by the AGU contribution are designated AGU scholars.

The sections accepted the responsibility for screening nominations for AGU fellows. It was thought that in this way applicants will be considered first by those most familiar with the field.

Touche Ross and Company was selected again as AGU auditors for 1981.

A $10,000 contribution was approved as seed money for planning a series of films in the geophysical sciences. The National Academy of Sciences is investigating the possibility of producing a new series along the lines of those produced after the IGY. If the films go into production, AGU will be listed among the sponsoring organizations.

The annual business meeting of the Union was held immediately after the adjournment of the Council meeting.

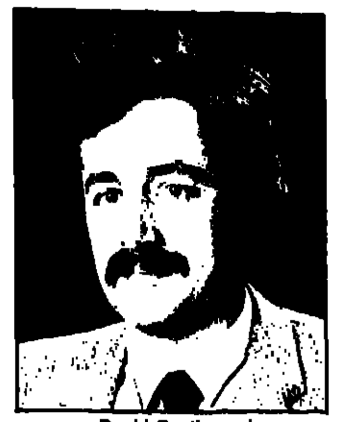
AGU Awards

The Twentieth Presentation of the

James B. Macelwane Award
to
Ronald J. Prinn, David Southwood, and Donald J. Weldner

In recognition of significant contributions to the geophysical sciences by a young scientist of outstanding ability

Ronald G. Prinn



David Southwood

Donald J. Weldner

Citation to Prinn

Mr. President, ladies, and gentlemen: We are honoring tonight a young scientist who combines an unusually broad knowledge of the chemistry and dynamics of planetary atmospheres with a healthy skepticism regarding established dogma and a marvelous ability to shrug off the displeasure of established dogmatists.

Ron Prinn's theoretical research has significantly influenced our understanding of the terrestrial stratosphere as well as the atmospheres of Venus and Jupiter. Since 1980, when he joined the Department of Meteorology at Massachusetts Institute of Technology, he has been a leading participant in collaborative efforts to develop numerical models of the stratosphere combining comprehensive chemistry with realistic dynamics. Such models have been a rich source of controversy in our continuing efforts to predict man's potential impact on the ozone layer. Prinn's work on the chemistry of sulfur gases in the atmosphere of Venus, published in 1973 and 1975, foreshadowed the explosive growth of interest in the sulfur chemistry of the terrestrial atmosphere. By delimiting conditions for the predominance of either sulfur or sulfuric acid in the clouds of Venus, his work provided a basis for the interpretation of Pioneer Venus data. It was Prinn who suggested that the spectacular dark markings on ultraviolet images of Venus are caused by sulfur. More recently he has discussed the contribution of phosphorus to the color of the Great Red Spot on Jupiter. Not forsaking the mother planet, he is currently engaged in efforts to determine from field measurements whether there is any truth in the well-established theory that freon, methyl chloroform, and nitrous oxide are chemically inert in the troposphere.

Mr. President, it is a privilege and pleasure to present Ronald G. Prinn for the James B. Macelwane Award.

James C. G. Walker and Ralph J. Cicerone

Acceptance

Thank you Jim for your very kind citation. I am flattered to be joining the distinguished list of previous recipients of the Macelwane Award. It is also a delight to be referred to as young again. Back when I was really young, I regarded people over 30 as definitely middle-aged. My work has required me to delve into more than one area of specialization. Fortunately, as I have wandered through the disciplines of meteorology, atmospheric chemistry, and planetary science, I have been treated with mercy by the professionals in these areas. Perhaps this is because the meteorologists think I am an atmospheric chemist, the atmospheric chemists presume I am a planetary scientist, and the planetary scientists see that I am in a meteorology department and my true profession must therefore be weather forecasting. However, I see that the awards committee contains representatives from all three of these disciplines, so I must be immune from such a rib at least for tonight.

Any recognition coming my way this evening must in fact be shared with a number of unselfish friends, collaborators, and colleagues. Let me take this opportunity to mention a few of these people who have influenced my directions in beneficial ways. John Lewis managed to entice me away from a career in molecular quantum mechanics and showed me that speculation can be an occasionally respectable vocation. Norman Phillips successfully guided me into the then largely alien environment of meteorology and was instrumental in the formulation stages of the stratospheric model, which Jim has mentioned. My collaborators in this modeling work, Fred Alyea and Derek Cunnold, have done a large part of the day-to-day work on the model and, in addition, are my collaborators in the fluorocarbon lifetime experiment, which has also been mentioned. Don Hunten has been burdened with refereeing an unseemly number of my publications and has been blunt when necessary and encouraging when needed. Gerry Wasserburg showed me by example that scientists should be actively involved in the occasionally thankless task of guiding and advancing their fields, and not merely reap the benefits of others' efforts in these endeavors.

The citation of my work in planetary atmospheres carries particular pleasure. It has frankly been a joyful task to explore the photochemistry of apparently exotic atmospheric species such as hydrogen chloride, carbonyl sulfide, phosphine, and thiozone. It is also my belief that research in planetary atmospheres can and has had important implications for our own atmosphere, in addition to having its own intrinsic fascination.

I sincerely thank President J. Tuzo Wilson and the American Geophysical Union, and in particular the Macelwane Awards Committee, chaired by Gerry Wasserburg, for this unexpected yet gladly accepted award.

Ronald G. Prinn

Citation to Southwood

It is indeed an honor and a pleasure for me this evening to introduce to you one of the recipients of the Macelwane award, Dr. D. J. Southwood of Imperial College, London, England. This award is presented annually by the American Geophysical Union for outstanding contributions by a young scientist. It is very fitting that David be selected this year.

David, a British citizen, was born in Torquay, England, in 1945. Mothers of small children take heart. According to David's mother he did not utter his first words until after the age of two. However, he has not been at a loss for words since. Shortly thereafter he entered Queen Mary College in London. Later he became a postgraduate student under Professor J. W. Dungey at Imperial College, under whom he wrote a thesis entitled 'Theoretical Studies of ULF Waves in the Magnetosphere,' receiving his Ph.D. in 1964.

Shortly after graduation, David spent a year at UCLA, continuing his work on magnetic pulsations and, on the side, teaching me much of what I know about the underlying physics of the magnetosphere. After his stay at UCLA he returned to Imperial College as a lecturer, but David soon got itchy feet again. However, since then he has usually satisfied his urge to travel by almost annual summer visits to the U.S. We at UCLA have been fortunate enough to have him join us five times in the last 10 years.

David's initial contribution to magnetospheric physics was a theoretical and experimental investigation of the Kelvin-Helmholtz instability at the magnetopause. He later looked at wave-particle resonances within the magnetosphere and their effects on cross L diffusion. Together with his student, W. J. Hughes, he examined the effect of the ionosphere on magnetic pulsations and brought order and comprehension to an otherwise confused situation. Together with Margaret Kivelson of UCLA he examined the effects of electric fields on magnetospheric particle motion and, in particular, aided in the understanding of the physics of particle injection into the magnetosphere. Most recently he has been putting order into our understanding of the way in which the Galilean satellite Io interacts with the Jovian magnetosphere.

I can't help remarking as I did here several years ago (*Eos*, 58, 872–873, 1977) that having a name in the latter half of the alphabet helps one to win the Macelwane award. However, David's deceptively simple name has also led him on occasion to gain less credit than he deserves. Recently, for example, he was referenced seven times in a paper as Southward (*Geophysical Research Letters*, 7, 881–884, 1980). On another occasion a proposal was sent into NSF with his name on the cover written as Smallwood. Perhaps tonight's ceremonies will help us remember David's real last name.

I would like to close this introduction by reading the citation prepared by the awards committee [and] which very accurately summarizes David's contributions to date.

Over the last 14 years, David Southwood has substantially advanced the application of magnetohydrodynamics to space plasmas and, particularly, to the earth's magnetosphere. His Ph.D. thesis on the Kelvin-Helmholtz instability at the boundary of the magnetosphere was a landmark in the field. Over the last decade, he has become perhaps the leading expert on the theory of magnetohydrodynamic waves in the magnetosphere. He has made a substantial contribution to the theories of magnetic-field-line resonance, of the generation of magnetic pulsations by the Kelvin-Helmholtz instability, and of the influence of the ionosphere as a boundary condition on magnetohydrodynamic waves. In general, his research was a major factor in the theoretical developments needed for the interpretation of the last decade's increasingly sophisticated space- and ground-based observations of 'geomagnetic micropulsations.' He has also worked actively and productively in other areas of space plasma physics. By means of clever but simple calculations, he has contributed significantly to the theory of large-scale plasma motions in the earth's magnetosphere and, particularly, to the understanding of the transport of particles into the ring current and the Van Allen belts. This work on the earth's magnetosphere, and also his very recent work on the interaction of Io with Jupiter's magnetosphere, has been characterized by creativity, by clear intuition, by deep understanding of physics, and by the precious ability to bring theory into effective contact with observations.

Christopher T. Russell

Acceptance

I am very honored to receive this award, and in spite of the citation you have just heard I think my ability has been to be in the right places and to work with the right people.

At Imperial College I work with two close colleagues, Jim Dungey and Stan Cowley, without whom I would not be here. I have worked with Jim since my postgraduate days, and one thing I am indebted to him for is converting me from a mathematician to a physicist, something I have not regretted.

There are large numbers of people I have worked with at UCLA. I shall single out Margaret Kivelson for mention. It is good to work with a clever colleague, even better if she has shared attitudes and complementary skills. I have also noticed she is charming and attractive and a stickler for correct use of grammar.

I have one unusual working relationship. My mother works in the same group as me. We have more or less worked out who works for whom. Though widowed when I was quite young, she successfully raised me and my brother. Late in life she started a technical education only to end up working in the same place as both her sons.

Another close relative to whom I owe a great deal is my wife, Sue, who has divided her attention between activities such as raising our three children, Anna, Michael, and Peter, and ministering to me more than I deserve, but also including setting up her own business and involvement in a variety of outside interests.

There are lots of other people who should share some of my glory. I cannot name them all, but I am aware that a very large fraction are American. Probably all Europeans speculate at some time on the American they might have been. I worked here enough to know, and I have had a fair immersion in American values. I am not original in pointing out values are often hilariously the opposite of my native British ones. Sincerity (or boring seriousness) is an American virtue. Cynical wit (or flippant insincerity) is a prized British social skill. I am busy cultivating a happy schizophrenia where I accept both sides. In particular I like American enthusiasm for hard work and your optimism about change. These latter attitudes make for a dynamism in U.S. science I have always found exciting. Thanks to you all for this.

Finally, let me say something on the virtues of travel. It broadens the mind, challenges the digestion, cements collaboration, helps international understanding but, unfortunately, costs money. I would like to thank the several funding agencies and grant-awarding bodies in the United Kingdom, United States, and elsewhere who have helped me to travel. Was it not a scientist who said, 'If I have traveled further than most, it is because I have been the holder of grants'?

David Southwood

Citation to Weldner

Mr. President, ladies, and gentlemen: I have the pleasure of introducing Donald J. Weldner. He has been a pioneer in the development of the Brillouin scattering method of measuring elastic moduli of minerals. Shortly after joining the faculty of the Department of Earth and Space Sciences at Stony Brook, New York, in 1972, he became interested in Brillouin scattering and started to build a research lab for the application of Brillouin scattering to the investigation of elastic properties of minerals. He recognized the value of the technique in making measurements on very small samples, a capability that makes it particularly attractive for examining quenched high-pressure phases and other samples that are available in very small sizes. In the short time since he established his lab, he and his colleagues and students have made measurements on many important rock-forming minerals and have reported the results in a number of excellent professional papers. In many cases the measurements were made on tiny specimens which are barely visible to the human eye and whose elastic properties could not have been measured in any other way. Concurrent with this work, he has continued his studies in seismology as well as [his] theoretical investigations [into] the elastic properties of crystals.

The development of a new technique and its application to the acquisition of data that would otherwise have been unobtainable is a big challenge. The success of Donald J. Weldner in this endeavor attests to his exceptional abilities as a scientist.

Donald Weidner is not only an accomplished scientist but a person who has already guided and inspired a number of promising younger scientists to begin careers in seismology and solid state geophysics. Mr. President and officers of the Union, I present Donald J. Weidner for presentation of the 1981 Macelwane Award.

Thomas J. Ahrens

Acceptance

Thank you Tom for your kind remarks. I also thank the American Geophysical Union for honoring me with this award.

This award is particularly gratifying to me insomuch as it relates to a few aspects of my life. Every morning when I confront the mirror I discover that my forehead has made yet another advance on my hairline. Even worse, those taller than I tell me that my forehead is about to conquer the very top of my head. I find my joints groaning as I do simple tasks. Graduate students are now handily trouncing me at squash. I look across the campus and ask who are these children, only to find out that they are the graduating class. With all of these observations at hand, I cherish the part of the Macelwane citation which reads "young scientist."

I am also very gratified by the recognition of my research given by this award. As I am sure is true of most of this audience, there have been many hard hours late at night, many frustrations, and a few successes. There are times when we wonder if anyone cares about what we're doing. There are times when we question if we shouldn't be doing something else. The monetary rewards associated with a faculty position are traditionally small. It is under these circumstances that an award such as this one serves to renew one's vigor.

But, in the final analysis we realize that we do not pursue science for the awards or personal recognition. As the physicist, mathematician, philospher Henri Poincaré once said, 'The scientist does not supply nature because it is useful: he studies it because he delights in it, and he delights in it because it is beautiful.' Clearly we hope that our results may be useful to others, but it is the beauty of nature and the excitement of discovery that drives us and not the pursuit of awards.

If Sir Isaac Newton 'stood on the shoulders of giants,' I stand as a dwarf among giants. Many people have helped me personally and professionally. Foremost, is my wife, Deborah, who has cheerfully helped and supported me both in the easy times as well as the hard ones. My brother Jerry showed me by example how a scientist should think. My advisor, Kei Aki, nurtured me at a young age and aided my development. Graduate students at Stony Brook both contributed to my research program and provided water from the fountain of youth. In particular, I wish to acknowledge Michael Vaughan, Alan Kafka, Jay Bass, and Andy Au. The institution of Stony Brook and my colleagues in the Department of Earth and Space Sciences have provided an atmosphere of stimulation, collaboration, and when necessary, equipment that has allowed my research program to advance. The National Science Foundation has been generous in their support. To all of these I am grateful.

Since learning that I was to receive this award I have, on many occasions, considered refusing it. One such time was when I had to prepare this speech. Awards such as this come with many liabilities. University administrations often equate recognition of achievement with administrative ability; the result being a quantum increase in university committee work. One's colleagues suddenly become more critical of the research program and question why the AGU committee ever chose this one to receive an award. More importantly, however, such an award brings more responsibility. The recipients must now live up to the honor that they receive. I am awestruck when I read the names of previous recipients of the Macelwane award. The tradition of accomplishment that they have set since receiving this award is intimidating, and living up to this tradition is truly a great challenge. I am honored to have my name listed along with theirs, and in the spirit of accepting this challenge, I gratefully accept the Macelwane award.

Donald J. Weidner

Sponsors of 1981 New Members

Two hundred fifty-nine new members were elected between May 1 and June 30, 1981. The AGU members who sponsored them are listed below.

Three Members: Alan R. Bandy, Richard L. Carlson, Neville L. Carter, H. W. Dosso, R. E. Horita, Gerard Lachapelle, Peter J. Maroulis, Lawrence A. Taylor.

Two Members: Bruce A. Bolt, Kevin Burke, Chen-Tung Chen, David M. Christie, Ralph J. Cicerone, Jacques W. Delleur, John F. Dewey, H. P. Eugster, R. Allan Freeze, Kazuya Fujita, G. D. Garland, Robert Geller, Hugh C. Heard, Mark H. Houck, Florian K. Lehner, Bruce D. Marsh, David W. McGrail, Ronald T. McLaughlin, Harry Y. McSween, Mario J. Molina, Peter Molnar, Mario Morisawa, James R. Rice, Gerald Schubert, K. P. Schwarz, George F. Sharman, A. K. Sinha, John M. Sinton, John C. Stormer, Jr., Francisco Suarez, T. E. Unny, Rob Van der Voo, David R. Veblen, James A. Whitney, David V. Wiltschko, Derek York.

One Member: Maha Abdalla, Sunil Kumar Addy, Thomas D. Aitken, James Iwan David Alexander, Raymond Anderson, Raymond E. Arvidson, Larry P. Atkinson, Milo M. Backus, Antoine Badan-Dangon, Samuel J. Bame, Aaron Barnes, Larry Barrows, Douglas R. Baumgardt, John W. Belcher, James P. Bennett, Jonathan H. Berg, Robert A. Berner, Robert L. Bernstein, Glenn O. Bertiaux, N. K. Bewtra, Kevin T. Biddle, Selena Billington, Jackson O. Blanton, James G. Blencoe, W. Frank Bohlen, Stephen L. Bolivar, W. F. Brace, Rafael L. Bras, David A. Brooks, Larry D. Brown, Robert C. Brown, Roger G. Burns, Peter Buseck, John C. Butler.

Douglas R. Caldwell, Malcolm J. Cambell, Philip A. Candela, G. R. Carignan, Richard W. Carlson, Robert F. Carlson, Robert S. Carmichael, Chalon L. Carnahan, Roy Carpenter, Edward Chang, Richard L. Chase, David Chavez, Abraham H. Chen, Garry K. C. Clarke, Lawrence Collin, Bastiaan Jacob Collette, Jim Constantz, Bruce H. Corliss, Peter Cornillon, Allan V. Cox, Patrick A. Crowley, C. Cunnane, Paul E. Damon, James F. Daniel, Khirod C. Das, Geffrey F. Davies, John N. Davies, Paul Davis, Richard W. Davis, David R. Dawdy, Roland A. de Szoeke, Anthony Charles Delany, Steven R. Dickman, Robert S. Dietz, S. Lawrence Dingman, Richard Ditteon, Janet A. Docka, John H. Doolittle, John J. Dowling, John J. Drake, Al Duba, Fredrick Duennebier, Timothy Durbin, William B. Durham, Robert F. Dymer.

Peter S. Eagleson, Stephen Ehrenberg, Leo M. Eisel, Robert M. Ellis, Brooks B. Ellwood, Terry Engelder, Irene M. Engle, Albert J. Erickson, E. J. Essene, J. R. Evans, David Fahlquist, Donald Farley, Gerald L. Feder, Michael Fehler, William C. Feldman, Myron B. Fiering, Erik G. Finnstrom, Harold Carlton Fitz, Jr., Donald W. Forsyth, Edward A. Frankovic, Carl Fricke, Cliff Frohlich, Yoshio Fukao, Anthony F. Gangi, Douglas H. Garbin, Michael O. Garcia, George Donald Garlick, Joel R. Gat, John William Geissman, Walter Gekelman, Daniel T. Georgi, Joe Gettrust, Christoph K. Goertz, Fraser Gogg, Alan Goodacre, Sarah Goodin, John T. Gosling, Dennis Grady, James W. Granath, Norman K. Grant, Ronald Greeley, John P. Greenhouse, Eugene Greestadt, L. Trowbridge Grose, D. Gubbins, John H. Guswa.

Bradford H. Hager, Douglas A. Haith, Francis R. Hall, James M. Hall, Leo M. Hall, Stuart A. Hall, Donald R. F. Harleman, Gregory D. Harper, Trevor Neil Hart, Akira Hasegawa, Richard H. Hawkins, Stanley P. Hayes, James Fred Hays, Walter J. Heikkila, Donald V. Helmberger, John H. Heledon, Jr., Jim Herring, Norman Herz, John B. Higgins, Joseph W. Hirman, Robert M. Hirsch, Eva J. Hoffman, John H. Hoke, Robert W. Houghton, Shih-Ang Hsu, Kenneth L. Hunkins, David Huntley, Violet Rosemary Strachan Hutton, Simon Ince, Mizuho Ishida, David D. Jackson, Wolfgang R. Jacoby, Raymond Jeanloz, A. I. Johnson, Peter Jumars, Glenn H. Jung, William A. Jury, Jack A. C. Kaiser, Douglas L. Kane, William M. Kastner, John Katsufrakis, Robert Kay, Elvin Kejlso, Paul Kintner, Paul H. Kirshen, Peter K. Kitanidis, David M. Klumpar, Kenneth P. Kodama, Nicholas Kouwen, Stamatios M. Krimigis, Richard J. Kullbert.

Paul E. La Violette, Theodore C. Labotka, Antonio C. Lasaga, Charles Russell Lawrence, Lawrence A. Lawver, Tay-How Lee, Tien-Chang Lee, Shaul Levi, S. Benedict Levin, Edward R. Levine, Robert C. Lieberman, Marvin Lilley, Robert J. Lillie, Thomas E. Lisle, Ivan Lissauer, S. W. Lohman, Marc Loiselle, Richard R. Luckey, W. C. Luth, Gregory A. Lyzenga, William D. MacDonald, Peter F. MacDoran, David C. Major, William V. R. Malkus, Jose Roberto Manzano, Quervain Marcel, George O. Marmorino, Philip Marsh, Edward A. Martell, John C. Maxwell, Michael J. McEachern, Patrick S. McIntosh, Malcolm C. McKenna, Dan McKenzie, William F. McKenzie, Karen McNally, R. H. McNutt, Murray S. McPherson, Michael O. McWilliams, Ronald Mees, H. J. Melosh, Wendell W. Mendell, Richard P. Mied, Chester Miller, Gary L. Mills, Andrew S. Milman, Hitoshi Mizutani, Allen Moench, Erik Mollo-Christensen, Eldridge Moores, Millett G. Morgan, Donald A. Morrison, Marshall E. Moss, W. R. Muehlberger.

Andrew F. Nagy, Michael T. Naney, T. N. Narasimhan, Donald R. Nielsen, Aharon Nir, D. Kirk Nordstrom, Dag Nummedal, Amos Nur, K. M. O'Connor, Jerry S. Olson, Peter Olson, Neil D. Opdyke, Marshall Orr, Harold D. Orville, Aaron J. Owens, Surendra Pal, Carl D. Palmer, James J. Papike, E. M. Parmentier, David K. Parrish, David F. Paskausky, Tsung-Hung Peng, Wayne D. Pennington, Mary Jane Perry, Alan R. Peterfreund, John A. Philpotts, Kathleen Poole, Thomas A. Polemra, Fredrick Prahl, Ronald G. Prinn, Edward L. Procyshyn, William A. Prothero, Jr., Philip D. Rabinowitz, Srinivas Q. Rao, Kenneth H. Reckhow, Ian Reid, R. J. Renard, Sol Resnick, Ray T. Reynolds, Philip G. Richards, Randall M. Richardson, A. K. Richter, Robert E. Riecker, John K. Robertson, Edwin S. Robinson, Robert Robinson, Raymond G. Roble, Michael G. Rochester, C. K. Ross, John W. Rudnicki, Patrick J. C. Ryall.

Nadi Adeeb Saad, Robert A. Saar, Takao Saito, Yosiko Sato, Ulrich Schmidt, Janet A. Schramke, Steven J. Schwartz, Harry E. Schwarz, Charles B. Sclar, Jon T. Scott, Donald R. Seely, Sandro Serra, Allen M. Shapiro, Denis M. Shaw, Kunihiko Shimazaki, Charles H. Shultz, David W. Simpson, Shri Krishna Singh, James R. Slack, Norman H. Sleep, A. P. Slootweg, Douglas Smith, Raymond C. Smith, Stuart D. Smith, J. Arthur Snoke, Bengt Sonnerup, Thomas W. Spence, Joseph J. Spigai, William A. Sprigg, P. Srinivasan, Jerry Russell Stedinger, R. R. Steeves, Reiner L. Stenzel, Don Silerman, Edward Stolper, Keith D. Stolzenbach, D. W. Strangway, Robert G. Strom, Wilton Sturges, John S. Sumner, Kiyoshi Suyehiro, Lynn Sykes.

Ronald C. Taylor, Michael D. Teubner, Lawrence W. Teufel, Thomas M. Tharp, Friedrich Theilen, Dana Thompson, Jr., Kent W. Thornton, Robert Thunnell, George R. Tilton, Alfred Toennissen, Marsha R. Torr, Allan H. Treiman, Carl Christian Tscherning, Jan Tullis, Terry E. Tullis, Donald L. Turcotte, Amjad Umari, Kenneth L. Verosub, J. Veverka, Thomas A. Vogel, Richard Vondrak, Joachim Voss, David Walker, Raymond J. Walker, Chi-yuen Wang, Wendell D. Weart, Thomas A. Weaver, John B. Weeks, Donald Weidner, Alan Welch, Erhardt P. Werth, Warren B. White, William B. White, Albert J. Williams, III, Douglas F. Williams, Richard T. Williams, Clark R. Wilson, John W. Winchester, Donald U. Wise, George T. F. Wong, Teng-fong Wong, Eric Wood, James Wright, Francis T. Wu, Kiyohumi Yumoto.

Travel Grants for IAGA and IAMAP Assemblies Awarded

AGU recently received from the National Science Foundation block travel grants for U.S. scientists to attend the Third Scientific Assembly of the International Association of Metérorology and Atmospheric Physics (IAMAP) to be held in Hamburg, Germany, August 17–28, 1981, and the Fourth Scientific Assembly of the International Association of Geomagnetism and Aeronomy (IAGA) to be held August 3–15, 1981, in Edinburgh, Scotland. The IAMAP proposal was cosponsored by American Meterorological Society.

A total of 54 scientists were funded with the two grants, and the scientists ranged in age from 26 to 71, with the average age of 42 for the IAMAP grant recipient and 39 for those receiving IAGA grants. Fifteen were from the eastern part of the country, 18 from the central part, and 21 from the west coast, including Alaska. Two students were among those funded, one from each grant.

There were 53 applicants for funds from the IAMAP grant. Of these, 33 were funded with average grants of $775. Four will go to both the IAGA and the IAMAP meetings: Janet G. Luhmann, Knut H. Stamnes, David J. Stevenson, and Robert G. Roper. Others receiving grants to attend the IAMAP meeting are Richard A. Anthes, Susan K. Avery, Louis J. Battan, Alfred K. Blackadar, David W. Buchanan, Andre A. Doneaud, Kerry A. Emanuel, Claude J. Frankignoul, Michael Garstang, David D. Houghton, Barry J. Huebert, Kolf O. Jayaweera, Carl W. Kreitzberg, Richard Gary Layton, Yeong-Jer Lin, Byard W. Mosher, David G. Murcray, Jerome Namias, Gregory D. Nastrom, Takeshi Ohtake, Joyce E. Penner, Roger A. Pielke, Ruth A. Reck, Gary J. Roitman, Philip B. Russell, David C. Sands, Vinod K. Saxena, Russell C. Schnell, and Anne M. Thompson.

There were 73 applications for funds to attend the IAGA meeting, of which only 21 could be funded. The average grant was $800. Grant recipients are Sushil K. Atreya, Subir K. Banerjee, Jeffrey M. Forbes, Michael D. Fuller, Suman Ganguly, John T. Gosling, John F. Hermance, David D. Jackson, Margaret G. Kivelson, Shailendra Kumar, Steven P. Lund, Christopher P. McKay, Christopher T. Russell, Michael Schulz, Thomas J. Shankland, Antony C. Fraser-Smith, Rob Van der Voo, Craig A. Tepley, Raymond J. Walker, Richard L. Walterscheid, and Richard A. Wolf.

Meetings

International Radio Science Meeting

The 1982 International Symposium sponsored by the IEEE Antennas and Propagation Society (IEEE AP-S), the National Radio Science Meeting sponsored by USNC/URSI Commissions, and the Nuclear Electromagnetic Pulse Meeting (NEM) will be held jointly at the University of New Mexico in Albuquerque, May 24–28.

A joint call for papers has been issued. Abstracts, due January 4, should be sent to Kendall F. Casey, The Dikewood Corp., 1613 University Boulevard, N.E., Albuquerque, NM 87102. Requests for general meeting information should also be directed to him. Inquiries on the technical program should be directed to the respective technical program committee chairman: IEEE AP-S: K. F. Casey and B. K. Singaraju; USNC/URSI: K. F. Casey; and NEM: K. C. Chen and L. D. Scott.

Information on accommodations and travel should be requested from Denise Griego, Albuquerque Convention and Visitors Bureau, 401 Second Street, N.W., Albuquerque, N.Mex. 87102 (telephone: 505/243-3969).

Coal's Effect on Water Quality

A call for papers has been issued for the International Conference on Coal-Fired Power Plants and the Aquatic Environment. The conference is scheduled for August 16–18, 1982, in Copenhagen, Denmark.

The meeting will address three sources of water pollution (thermal, solid waste, and airborne particles) and the corresponding prevention measures.

The conference is sponsored by the International Association on Water Pollution Research, the International Union of Pure and Applied Chemistry, and the Nordic Cooperative Organization for Applied Research.

December 31 is the deadline for abstracts. For additional information, write to Dis Congress Service, Linde Alle 48, DK-2720 Copenhagen, Denmark.

1981 Spring Meeting Report

Approximately 2150 participants registered for the 1981 Spring Meeting. More than 1500 papers were presented.

The spaciousness of the Baltimore Convention Center provided ample opportunity for attendees to exchange ideas and interact with their colleagues. Here are some candid shots.

Changes to the program and late and revised abstracts are printed below.

Papers Not Presented

G36, K. S. Wallace et al.

GP58, T. M. Hoar and C. K. Seyfert

H73, D. P. Dethier; H75, S. W. Wheatcraft and R. W. Buddemeir; H79, L. E. Dunlap and J. M. Spinazola.

M2, R. M. Endlich et al.; M9, P. G. Black et al.

016, C. T. Carlson et al.; 018, W. McLeish et al.; 076, R. Chambers and N. Hawley; 0103, R. J. Spencer et al.; 0132, F. R. Siegel and S. Bloch; 0133, T. J. Barrett; 0134, T. J. Barrett et al.; 0152, D. G. Aubrey and P. E. Speer.

P45, S. Kumar and H. A. Taylor, Jr.; P54, T. E. Cravens et al.

S9, R. G. Daniel; S10, M. Caputo; S31, S. R. Taylor; S33, M. E. Monfort; S61, C. A. Langston; S87, C. A. Tosaya.

SA62, S. Ganguly.

SM39, D. R. McDiarmid; SM58, P. F. Fougere; SM60, R. D. Sears; SM67, C. W. Dubs; SM93, H. H. Sauer et al.; SM142, H. A. Garcia; SM174, W. Calvert.

T39, M. C. Malin; T40, M. P. Ananda et al.; T78, O. L. Anderson and Y. Sumino; T101, S. N. Cohn; T141, G. Mavko; T188, L. D. McGinnis et al.

V2, A. Meijer; V55, B. C. Chakoumakos and G. V. Gibbs; V77, J. Hamet et al.; V144, T. A. Hudson and R. D. Dallmeyer; V152, A. A. Eggers; V191, A. Baldasari; V208, E. S. Patera et al.; V209, J. R. Smyth and F. A. Caporuscio; V210, S. Bloch.

Late Abstracts

G4 INVITED PAPER

ALTIMETRY IN GEODESY AND GEOPHYSICS

A. B. Watts
S. Bauby
E. Zorai
K. Turner (all at: Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York 10964 and Department of Geological Sciences of Columbia University, New York, New York 10027)

The advent of altimeters on orbitting satellites, beginning with SKYLAB in 1973 and GEOS-3 in 1975, has enabled the gravity field over the oceans to be determined with great precision. Radar altimeters measure the distance between the satellite and the instantaneous sea-surface which, in oceanic regions corresponds closely to the geoid. This geoid includes disturbances due to oceanographic effects such as tides, storm surges and tsunamis but these are generally small (1 meter or less) compared to disturbances due to density differences in the Earth (a few meters to a few hundred meters). The direct measurement of the geoid is currently having an important impact in both geodesy and geophysics. Altimeter data is being used to recover 1°x 1° mean gravity anomalies in the oceans and to improve gravity field models. Prominent geoid anomalies of amplitudes up to 4 to 9 meters and wavelength λ≈ 50 to 1500 km have been observed over seamounts, aseismic ridges and oceanic plateaus, fracture zones and continental margins. These anomalies have provided information on the nature of isostasy in the oceans, particularly the depth of the compensation. In addition, longer wavelength geoid anomalies (λ≈ 3000 to 4000 km) are providing information on geological processes not related to isostasy and the mechanical properties of oceanic lithosphere. These include the thermal structure of oceanic lithosphere and the depth and plan form of convection in the Earth's mantle.

GP6A POSTER

A FIRST LOOK AT THE MAGSAT ANOMALY MAP, EMPHASIZING AFRICA

David A. Hastings (Technicolor Graphic Services, EROS Data Center, Sioux Falls, SD 57198)
(Sponsor: R. A. Langel)

The preliminary scalar anomaly map compiled from magnetic field satellite (MAGSAT) data closely resembles the map derived from POGO (Polar Orbiting Geophysical Observatory) data, though with considerably greater detail. In Africa, as elsewhere, the preliminary MAGSAT anomaly map tends to emphasize E-W trending tectonic features such as the Karroo Basin, and subdue N-S features such as the East African Rift System. This is expected, as the greatest net magnetization of crustal bodies occurs along the sides of E-W bodies, but only at the ends of N-S bodies. A second contributing factor might be MAGSAT's N-S orbit, without E-W tie lines, coupled with filtering of the data only along-track. In the northern hemisphere, the main sources of scalar MAGSAT anomalies are older Precambrian shields (generally negative anomalies) and sedimentary basins of various ages (generally positive). The younger Precambrian (Pan African) "mobile belts" tend not to produce marked scalar MAGSAT anomalies. Magnetic anomalies for given types of features change polarity south of about 10°S lat. in Africa, whereas the magnetic equator lies at about 10°N.

Of particular interest in Africa is the strong correlation between the "Bangui anomaly" and known regional tectonic features. The central negative anomaly correlates well with the E-W Central African Shield. The Chari Basin – Bénue Trough and the Congo Basin appear to control the positive anomalies flanking the Bangui anomaly on the N and S, respectively. The consistency of this correlation with other tectonic associations of MAGSAT anomalies in Africa suggests this as an alternative hypothesis to that of Regan and Marsh of the cause of the Bangui anomaly.

The anomaly patterns in Africa and adjacent oceanic areas are broadly representative of global patterns between the mid-latitudes.

H8 INVITED PAPER

MODELS AND WATER RESOURCES DECISION-MAKING

Chris Ansell
Nancy Ikeda
Robert N. Friedman (Office of Technology Assessment, U.S. Congress, Washington, D.C. 20510)

We investigated the use of models for water resource decision-making: by 19 federal agencies, by all 50 states, and for 13 major resource problems. Preliminary findings include:
1. Models are most often used to assist operational management and small-scale planning. They have less successfully been integrated into comprehensive river basin planning and policy making.
2. Although water resource model use is extensive at the federal level, coordinated modeling efforts have been rare.
3. While most states currently use models, many states would like to broaden their modeling capabilities. However, due to limited resources and poor information about model availability, most states are unable to improve their capabilities.
4. There is a wide variation in the quality and utility of water resource models. However, information about the quality or appropriate use of these tools is difficult to obtain, and in many instances unknown due to a lack of model evaluation.
5. In the past, model development activities have received primary emphasis, without adequate attention to technology transfer and user support. Attention to institutional support, as well as a problem solving approach, has been lacking.

HC INVITED PAPER

FEDERAL RESEARCH SUPPORT FOR MODELS

William S. Butcher (Division of Civil and Environmental Engineering, National Science Foundation, Washington, D.C. 20550)

The use of water resources models is pervasive throughout the Federal Agencies concerned with water resources planning and management. Agencies with a specific action mission, both use and develop water resources models through in-house or extra-mural activities. Other agencies whose mission is general research such as the National Science Foundation and the Office of Water Research and Technology through research, produce models for other researchers and for professionals at large.

Many important models have been produced by federal agencies. Some are special purpose, e.g. in the U.S. Army Corp of Engineers and EPA. Others are general purpose and/or experimental.

Research has been largely responsible for the increase in relevance and currency of present models available and is proceeding to extend the range and power of presently available models.

HD INVITED PAPER

THE EFFICACY OF WATER RESOURCES MODELS: MODEL DEVELOPERS PERSPECTIVES

Jared Cohon (Department of Geography and Environmental Engineering, Johns Hopkins University, Baltimore, Maryland 21218)

HE INVITED PAPER

SESSION OVERVIEW

Y. Y. Haimes, Director, Center for Large Scale Systems and Policy Analysis, Case Western Reserve University, Cleveland, Ohio 44106

The purpose of this session is to evaluate the efficacy of modeling in water resources focusing on the following aspects and issues:
(1) How responsive are these models to the needs of solving Water Resources problems today?
(2) How credible are these models?
(3) How useable are these models for planning, operational, and policy decisions by local, state and federal agencies?
(4) How credible is the data base?
(5) Are there coordination problems among model developers and users, and how can they be resolved?
(6) Are there model maintenance problems, and how can they be solved?
(7) What technology transfer problems exist, and how should they be addressed?
(8) What training and educational problems exist, and what should be our response?

The scheduling of this session coincides with the planned release of a study report on the subject conducted by the Congressional Office of Technology Assessment.

H2A INVITED

WATER BALANCE AND FLUSHING TIME AS FACTORS IN

MID-WEST LAKE ACIDIFICATION

Orie Loucks (The Institute of Ecology, Indianapolis, IN. 46208)

H2B INVITED

SNOWPACK ACCUMULATION OF STRONG ACIDS AND RELEASE DURING SPRING MELT

Dean S. Jeffries (Limnology and Toxicity Section, Ontario Ministry of the Environment, Box 213, Rexdale, Ontario, Canada).
W.R. Snyder.
(Sponsor: R.M. Friedman)

Bulk deposition and snowpack accumulation of H^+, Ca^{2+}, NH_4^+, SO_4^{2-}, NO_3^-, and Cl^- has been measured at several locations in south-central Ontario. Parameter concentrations in integrated snowpack samples change over the course of the winter and are commonly lower (particularly SO_4^{2-}) than the corresponding bulk deposition. Assessment of the snowpack profile suggests that the reduced concentrations occur through loss of ions by downward migration. During periods of snowmelt, stream concentrations exhibit differing relationships with discharge, depending on ion. Calcium and alkalinity concentrations are reduced up to 10-fold during spring runoff, while SO_4^{2-} concentrations remain constant and H^+ increases up to 10-fold. The input of H^+ associated with spring melt constitutes a significant portion of the total annual H^+ loading supplied by their watersheds for many lakes in central Ontario. Consideration of SO_4^{2-}/NO_3^- ratios has allowed assessment of the relative importance of the components of the strong acidity in bulk deposition, the snowpack, and stream waters.

H27A INVITED

SOCIAL TRENDS AFFECTING DESERTIFICATION: THE CASE OF THE ARID WEST

Evan Vlachos, Dept. of Sociology, Colorado State University, Ft. Collins, Colorado 80523

This paper attempts to describe social trends and developments associated with dry environments in the U.S. while addressing conceptual and methodological challenges around the widely debated concept of "desertification."

The vast arid area between the Sierra Nevada and the 100th meridian is characterized by: (a) fragile ecosystems and potentially stressful environmental conditions; (b) a changing social environment, resulting from rapid urbanization, sprawl, and industrialization which increases the risk of "desertification" for larger segments of population; (c) responses to "desertification" which are becoming quite complex as an increasing number of interdependent systems are affected; (d) proactive strategies that are becoming part of long-range policies requiring a more holistic natural resources emphasis and a shift from "crisis management" to "risk management;" (e) a need for a broader mobilization of institutions and people in order to accommodate policies for resource scarcities, climatic vagaries, and the uncertainty of future environments.

Given the vastness of the arid West, the growing impacts, the accelerated change, and their synergistic effects, a broader understanding of natural resources use, societal transformations within and outside the region, regional historical conditions, and long-range ramifications of man-induced carrenness, is needed.

DISCUSSION TOPIC: WATER AVAILABILITY FOR SYNTHETIC FUEL DEVELOPMENT, INTRODUCTION

Paula J. Stone (Office of Technology Assessment, United States Congress, Washington, D.C. 20510)

H37A INVITED

DISCUSSION TOPIC: WATER AVAILABILITY FOR SYNTHETIC FUEL DEVELOPMENT, OVERVIEW

Leo M. Eisel (Wright Water Engineers, Inc., Denver, Colorado 80211)
(Sponsor: P. J. Stone)

H37B INVITED

DISCUSSION TOPIC: WATER REQUIREMENTS FOR SYNTHETIC FUEL PLANTS

Harris Gold (Water Purification Associates, Cambridge, Mass. 02142)
(Sponsor: P. J. Stone)

H37C INVITED

DISCUSSION TOPIC: WATER AVAILABILITY FOR SYNTHETIC FUEL DEVELOPMENT, DATA

Frederick A. Kilpatrick (USGS, Reston, Virginia 22092)
(Sponsor: P. J. Stone)

H37D INVITED

DISCUSSION TOPIC: WATER AVAILABILITY FOR SYNTHETIC FUEL DEVELOPMENT, NATIONAL PERSPECTIVE

Gerald Seinwill (U.S. Water Resources Council, Washington, D.C. 20037)
(Sponsor: P. J. Stone)

H37E INVITED

DISCUSSION TOPIC: WATER AVAILABILITY FOR SYNTHETIC FUEL DEVELOPMENT, REGIONAL PERSPECTIVE

Harvey Banks (Camp Dresser McKee, Inc., Belmont, California 94002)
(Sponsor: P. J. Stone)

H37F INVITED

DISCUSSION TOPIC: WATER AVAILABILITY FOR SYNTHETIC FUEL DEVELOPMENT, INDUSTRIAL PERSPECTIVE

To be Announced

H37G INVITED

DISCUSSION TOPIC: WATER AVAILABILITY FOR SYNTHETIC FUEL DEVELOPMENT, CASE STUDY OF THE YELLOWSTONE RIVER BASIN

Constance M. Boris (University of Michigan, Ann Arbor, Michigan 48109)
(Sponsor: P. J. Stone)

H58A INVITED

THE NEED FOR DATA TO RELATE DRINKING WATER AND HEALTH

Riley D. Housewright, American Society for Microbiology, 1913 I Street, N.W., Washington, D.C. 20006. Formerly, National Academy of Sciences, Washington, D.C.

A series of three books on Drinking Water and Health have been published by the National Academy of Sciences in the past four years and a fourth volume is in preparation. The literature searches required for the preparation of these volumes have brought to our attention several serious gaps in the data required for making sound decisions concerning the relationship between the presence of contaminants in drinking water and health. These deficiencies are especially noticeable in the areas of reporting, detection, modeling, and evaluation of toxicological consequences of ingesting contaminants. This paper will call attention to specific deficiencies in these and other areas.

H56A

SEASAT SAR RESPONSE FROM WATER RESOURCES PARAMETERS

Bruce J. Blanchard
A. T. C. Chang (both at: Earth Survey Applications Division, NASA/Goddard Space Flight Center, Greenbelt, Md. 20771)
Andrew J. Blanchard (Texas A&M University, College Station, Texas 77843)

An initial investigation of the Seasat synthetic aperture radar (SAR) data was directed toward estimation of soil moisture, vegetation type, surface roughness due to tillage and flood extent under forest canopy. The SAR response was validated with a series of data sets from an L-band scatterometer flown in the NASA C-130 aircraft. Soil moisture in the surface 15 cm from fields of milo, alfalfa and bare soil produce similar differences (9 db range) in the scattering coefficient from both systems. Most agricultural vegetation was effectively transparent and was penetrated by this wavelength. Corn produces exceptionally high returns, however, there was evidence that tillage roughness could be detected through the corn canopy. Forest canopy in contrast produces moderate returns except when the forest floor is flooded. Flooded forest produced 4 to 6 db higher scattering coefficients than non-flooded forest for both the SAR and scatterometer. There was no detectable difference in response from conifer and deciduous forest canopy. Circular tillage patterns were used to illustrate the look angle dependence of row direction effects on the radar return. Roughness due to tillage can produce as much as 12 db increase in return. The Seasat SAR produced valuable information and in some instances would enable estimates of parameters that are not feasible with any other known system.

[illegible]

SEA ICE DISPLACEMENT FROM SEASAT SYNTHETIC APERTURE RADAR

R. T. Hall and D. A. Rothrock
(Polar Science Center, University of Washington, 4057 Roosevelt Way NE, Seattle, WA 98105)

Images obtained by a synthetic aperture radar on SEASAT have been used to measure sea ice displacements over a three day interval in October 1978. The data points lie roughly along a line and are quite dense—about 2 km apart—over a distance of 861 km. The displacements are about twenty kilometers. Displacement errors grow with distance from shore becoming as large as 3 km. The graph of displacement versus distance has occasional discontinuities of several kilometers. Displacement discontinuities are accurate to ± 0.07 km along track and 3% of their magnitude across track.

P29A

LUNAR POLAR WANDERING

S. K. Runcorn (School of Physics, The University, Newcastle upon Tyne, NE1 7RU, England)

Polar wandering, or reorientation with respect to the axis of rotation occurs if mass is redistributed on a planetary body and if its interior flows by solid state creep under small stress differences. This process might be expected to have occurred during the early history of the Moon and Mars. Evidence for this occurrence on the Moon is provided by the palaeomagnetic directions. [illegible] and colleagues have successfully modelled the magnetic anomalies detected by the Apollo 15 and 16 subsatellites. The dominance of the Coriolis force in the postulated fluid lunar core leads to the assumption of an axial dipole field. Strong arguments exist for interpreting the directions of magnetization of the crust as the ancient lunar field directions. The pole positions corresponding to them fall into antipodal groupings along three different axes, interpreted as representing three different eras. Polar wandering is interpreted as being caused by the last great impacts and their later flooding with lava to produce the mascons.

S73A

THE P/S VELOCITY PRECURSOR: A DERIVATION FROM A STOCHASTIC MODEL OF FRACTURATION

R. Benitez (Venezuelan Foundation for Seismological Research - Apartado 1892, Caracas 1010, Venezuela)

Stochastic Perturbation Theory is applied to the propagation of elastic body waves in a randomly stratified medium. For the P and SV modes there results both attenuation and dispersion; for the SH mode only attenuation obtains. These effects are the result of the contribution of all orders of a [illegible] perturbation of the elastic wave. [illegible] The fractional Perturbation Theory is applied to the P and S modes [illegible] of the elastic moduli [illegible]. It is taken to be larger than the vertical scale [illegible]. Then [illegible] the ratio of velocities [illegible]. When preferentially vertical fractures proliferate in the epicentral region the length [illegible] is taken [illegible]. This changes several parameters in the velocity ratio [illegible] which depends on the following parameters [illegible]. The number [illegible] may be estimated, in a two-dimensional model, as the fractures density per unit area. Physically acceptable estimates of the relevant parameters yield a fall in r of the observed magnitude.

S101A

SOME COMMENTS ON THE RELATIONSHIP OF TRAVEL TIME ANOMALIES, MAGNITUDE RESIDUALS AND OTHER GEOPHYSICAL PARAMETERS

Michael J. Shore (Department of Earth and Planetary Sciences, Johns Hopkins University, Baltimore MD 21218)

Many authors have suggested that worldwide correlations exist between various parameters. The correlations are normally attributed to the physical properties of the low velocity zone and uppermost part of the mantle. In support of body wave attenuation studies, researchers would like to develop indirect measures which could reliably predict the relative differences in attenuation at widely spaced stations.

Measurements of travel time residuals, magnitude residuals and Pn velocity, were tabulated for 90 seismic stations from published sources. Heat flow measurements were obtained from the 1976 NOAA Worldwide Data Base and geoid values were extracted from a 1979 NASA satellite geoid. Evaluation of the data indicates a linear correlation coefficient (r) of 0.7 for body wave magnitude residuals and Pn velocity. Less significant correlations (r = 0.5 to 0.6) are noted between magnitude residuals, Pn velocity and the geoid with travel time residuals, and between heat flow and Pn velocity (r = 0.4). Heat flow is poorly correlated with magnitude residuals, travel time residuals, and geoid level.

Even though the strongest correlation was observed between magnitude residuals and Pn velocity, magnitude residuals could only be predicted with 95% confidence for a given Pn velocity to ±0.24 magnitude units. Therefore, the use of alternative geophysical parameters to predict magnitude residuals at a particular station does not appear accurate enough to significantly improve individual station measurements.

SA76A

OPTICAL AND RADAR COLLABORATIVE RESEARCH IN ALASKA AND GREENLAND

J. W. Meriwether, Jr.
P. B. Hays
A. F. Nagy (all at: Space Physics Research Laboratory, University of Michigan, Ann Arbor, Michigan 48109)

Collaborative research between optical instrumentation and the incoherent scatter radar provide valuable complementary data about the state of the atmosphere. Optical means such as interferometers, spectrophotometers, and interference filter photometers may be used to measure thermospheric neutral winds, neutral temperatures, and airglow or auroral surface brightnesses as a function of time or direction. The radar provides data for the ionospheric electric field, the electron density, ion and electron temperatures, and ion drifts also as a function of time or direction. The two sets of information provide a unique foundation for aeronomical studies of auroral chemistry and dynamics. Typical areas featuring such collaborative research in Alaska for the last ten years will be reviewed, and our plans for an optical facility at Sondre Stromfjord proposed to the National Science Foundation will be discussed.

SM10A

SIMULTANEOUS MEASUREMENTS OF VLF TRANSMISSIONS IN THE MESOSPHERE AND STRATOSPHERE

C.R. Cornish, R.F. Pfaff, S. Powell, P. Kintner, M.C. Kelley (School of Electrical Engineering, Cornell University, Ithaca, NY 14853)
R. Holzworth (The Aerospace Corporation, P.O. Box 92957, Los Angeles, CA 90009)

Continuous VLF signals from earth-based transmitters were received between 60 and 90.2 km by a Nike-Orion sounding rocket and at 30 km by a high altitude balloon. The rocket was launched at 0224 UT on August 14, 1981 at Wallops Island, Virginia, and performed three orthogonal wave measurements using symmetric double probe electric field sensors spaced 5.5 meters apart. All three channels received broadband signals, for which telemetry considerations limited their maximum frequency responses to 20.0 KHz, 18.6 KHz, and 10.5 KHz. Many discrete transmissions were received of which the OMEGA and NAA transmitters have so far been identified. The balloon, with double probes spaced 3 meters apart, was also launched at Wallops Island, and received continuous data from 2:15 to 3:15 UT at 30 km altitude in a filter channel centered at 17.8 KHz. The received signal, which we believe originated at the NAA Transmitter in Maine, was modulated at the balloon spin period of 21 seconds and provides a "baseline" power measurement. At this same frequency, the rocket measured a strong continuous signal whose power level showed a marked decrease (5-7 dB) in the region between 70 and 80 km on both the upleg and downleg. We investigate these received power levels in light of the electrical characteristics and conductivities of the mesosphere.

V38A

PARABOLIC DISSOLUTION KINETICS - AN ARTIFACT OF PRECIPITATION?

G. R. Holdren, Jr. and J. E. Adams (Dept. of Geological Sciences, University of Rochester, Rochester, N. Y. 14627)

The rate limiting step for the dissolution of feldspar and other primary silicate minerals is thought to be a surface controlled reaction process. According to this model, the rates of dissolution for these minerals should be constant through time in dilute aqueous solution under conditions of constant solution pH, mineral surface area and stirring rate. This prediction is in conflict with a large body of experimental evidence which suggests that the dissolution kinetics of these minerals follow a parabolic rate law.

Data have been collected which suggest that this discrepancy may result, in part, from the nonequilibrium precipitation of amorphous aluminosilicates which occurs during the course of dissolution experiments. Experiments have performed to observe the kinetics of formation of amorphous precipitates under conditions which are similar to those employed in mineral dissolution studies. Concentrated (0.05N) Al- and Si- containing solutions were slowly and continuously added to 1.5 to 2.0 liters of buffered aqueous solution (pH ~ 6.1). The addition rates were such that total Al and Si concentrations increased linearly with time. Results indicate that the rates of formation of the amorphous aluminosilicate precipitates increase during the course of an experiment, producing apparent addition rates for silicon. These results strongly suggest that the nonlinear dissolution kinetics observed in previous mineral dissolution studies may, to an extent, be artifacts of secondary precipitation reactions which occur in those systems. Also, the results suggest that the actual dissolution processes need not be affected by and are taking place independently from the precipitation reactions.

An Overview of National Science Foundation Programs in Astronomical, Atmospheric, Earth and Ocean Sciences

1450 M. Grant Gross (Division of Ocean Sciences)
1510 Edward P. Todd (Division of Polar Programs)
1530 Peter S. Wilkniss (Division of Ocean Drilling Programs)
1550 F. Robin Brett (Division of Earth Sciences)

NSF, through the Directorate for Astronomical, Atmospheric, Earth and Ocean Sciences (AAEO), is a major source of support for research in the earth related sciences and astronomy. The AAEO Directorate supports the national astronomical observatories, the National Center for Atmospheric Research, the academic fleet, the U.S. Antarctic Program and the ocean drilling programs. Representatives of the AAEO Divisions of Atmospheric Sciences, Oceanographic Sciences and Earth Sciences, the Division of Polar Programs and the Division of Ocean Drilling Programs will discuss the status of current programs and possible future developments.

Revised and Additional Abstracts

V44 REVISED

ORDER-DISORDER KINETICS IN FERROMAGNESIAN SILICATES, AND THE COOLING HISTORY OF ROCKS.

Jibamitra Ganguly (Dept. of Geosciences, University of Arizona, Tucson, AZ 85721)

In many ferromagnesian silicates, Fe^{2+} and Mg are disordered over two or more nonequivalent crystallographic sites. The temperature of the cation distribution depends on the rate of cooling of the host rock. A natural crystal has been quenched, depends on the rate of cooling of the host rock (Tq < the temperature of apparent equilibrium of the quenched ordering state). Solution for Tq has been obtained for the non-linear cooling model, $1/T = 1/T_o + c(\ln t)$, from Mueller's (1969) kinetic treatment of intracrystalline exchange. Numerical method and program have been developed to calculate the change of site occupancy, X, as a function of T (which is a function of time in cooling system) for any rock cooling model. The cooling rate constant can be varied until the calculated X vs. T relation reproduces the observed quenched state. The model has been applied to a number natural pyroxene and Ca-poor amphiboles. The kinetic data for orthopyroxene by Virgo and Hafner (1969) and Besancon (1980, AGU Spring Meeting) have been applied to the data for intracrystalline distribution of Fe and Mg for a clinopyroxene sample from Kimberlite (McCallister, et. al., 1976, Amer. Mineral., 61; sample #PHN 1600X). It is assumed that the energetic properties of Fe- and Mg-centered octahedra are similar in the two silicates, and the effect of Ca is limited to simply blocking a certain number of M2 sites from participating in the intracrystalline exchange of Fe and Mg. The two sets of kinetic data yield approximately 6 days and one year, respectively, for the cooling of the sample to Tq, which is ~ 620° C. From paleomagnetic study, McFadden (1973) suggested 550-620° C for the intrusion temperature of the host kimberlite.

G44 REVISED

ALTERNATIVE FILTERING TECHNIQUES APPLIED TO THE EARTH'S GRAVITY FIELD

Christopher Jekeli (Department of Geodetic Science, The Ohio State University, Columbus, Ohio 43210)

Well known filters in Fourier spectral analysis, such as the rectangular, Gaussian, and Hanning filters, are adapted for data on a sphere. The different smoothing properties can best be studied by examining the corresponding frequency response functions (i.e. the spectra of the filters). The low-pass filter most often used on gravity data is the rectangular (or Pellinen) filter. However, its spectrum has relatively large sidelobes; and therefore, this filter passes a considerable part of the upper end of the gravity spectrum. The spherical adaptations of the Gaussian and Hanning filters are more efficient in suppressing the high-frequency components of the gravity field since their frequency response functions are strongly tapered at the high frequencies with no, or small, sidelobes.

Seismology

THE EFFECT OF RUPTURE COMPLEXITY ON ESTIMATES OF STRESS RELEASE

John Boatwright, U.S. Geological Survey, Menlo Park, CA 94025

(sponsored by R. Archuleta)

The shear waves radiated by eight multiply recorded aftershocks (3.6 M_L 4.9) of the 1975 Oroville, California, earthquake have been analysed for a variety of time-domain and spectral measurements. The relative complexity of the velocity waveforms is quantified to estimate the the rupture complexity and thereby bound the average rupture velocity. The measurements of corner frequency, characteristic frequency, rupture phase duration, and pulse duration are inverted for estimates of the source size. The inversions of the duration measurements fit the variation with takeoff angle to estimate the rupture geometry. The comparison of source size estimates indicates that for complex earthquakes the corner frequency is more sensitive to the sub-event size than the overall event size.

Five different estimates of stress release are considered over the data set. The apparent stress, the dynamic stress drop and a stress drop estimated from the rms acceleration of the shear wave arrivals give robust estimates (85-250 bars) which correlate remarkably well across the eight events. The static stress drop determined using the rupture areas calculated from the pulse durations correlates adequately with the three dynamic stress drop estimates, while Brune's estimate of static stress drop correlates poorly with the other estimates. In general, the estimates of static stress drop are less reliable than the estimates of dynamic stress drop.

SPR: Magnetospheric Physics

SATURNIAN KILOMETRIC RADIATION OBSERVED BY VOYAGER-1 NEAR TITAN

M. L. Kaiser
M. D. Desch (both at NASA/Goddard Space Flight Center, Laboratory for Extraterrestrial Physics, Planetary Magnetospheres Branch, Greenbelt, Maryland 20771)

The radio emission observed at 56 kHz when the Voyager-1 spacecraft flew past Titan has been proposed as emanating from Titan itself. We have examined the observations made by the Voyager-1 and 2 Planetary Radio Astronomy instruments during this period. Both spacecraft detected strong emission over the band from about 40 kHz to 200 kHz. Since Voyager-2 was then some 1.8 AU from Saturn, we were able to compare the measured signal strengths with those expected from a Titan radio source. Assuming both spacecraft could equally well view the source, we would expect the signal to be some 96 dB weaker as observed by Voyager-2 compared with Voyager-1. In fact, the measured signal difference is about 47 dB which is almost exactly that expected if the source were at Saturn rather than Titan. Therefore, we conclude that the emission detected by Voyager-1 near Titan closest approach is simply Saturnian Kilometric Radiation, and not a new radio source.

MAGNETOPAUSE MODELING, USING ISEE-1 ENERGETIC PARTICLE DISTRIBUTIONS

T. W. Speiser (NOAA Space Environment Laboratory, Boulder, CO 80303)
D. J. Williams
(Also at Dept. of Astro-Geophysics, University of Colorado, Boulder, CO 80309)

Several magnetopause crossings are observed on the inbound pass of ISEE-1 on November 10, 1977. The observed three-dimensional energetic ion distribution functions (24-120 keV) are studied in the magnetosphere, the magnetopause and magnetosheath. Selected magnetospheric and sheath measurements are used to initialize particle orbits in a simple one-dimensional quasi-static model. Proton orbits are followed from the magnetosphere into the sheath and a modeled sheath distribution is constructed, using Liouville's theorem, which is then compared to the observed distributions. The model is consistent with the observations for an inward-pointing normal magnetic field component and for tangential electric fields less than about 1/2 mV/m. This model seems to work both for "flux transfer events" and neighboring "quasi-trapped" sheath distributions, implying that the region of open field lines in the sheath may be broader, not quite as local, as previously thought. Protons of different energies and pitch angles sample different regions of the magnetopause. This result, coupled with some of the observations, lends qualitative support to the conjecture that tangential electric fields above our upper limit may exist over localized regions of the magnetopause.

Geophysical Year

(Boldface indicates meetings sponsored or cosponsored by AGU.)

1981

July 21–23 **Chapman Conference on Spatial Variability in Hydrologic Modeling,** Fort Collins, Colo. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

July 21–30 21st General Assembly of IASPEI, London, Ontario, Canada. (A. E. Beck, Department of Geophysics, Univ. of Western Ontario, London, Ontario N6A 5B7 Canada.)

July 27–30 **Eighth International Symposium on Urban Hydrology, Hydraulics, and Sediment Control,** Lexington, Ky. (Don J. Wood, Department of Civil Engineering, 206B Anderson Hall, Univ. of Kentucky, Lexington, KY 40506.)

Aug. 3–15 IAGA Fourth Scientific Assembly, Edinburgh, United Kingdom. (B. R. Leaton, Institute of Geological Sciences, Edinburgh EH9 3LA United Kingdom.)

Aug. 4–7 International Conference on Energy Education, Providence, R.I. (Donald Kirwan, Conference Chairman, Office of Energy Education, Univ. of Rhode Island, Kingston, RI 02881.)

Aug. 9–15 Symposium on Variations in the Global Water Budget, Oxford, United Kingdom. Sponsors, ICCL, IAHS, INQUA. (Prof. R. E. Newell, Department of Meteorology, 54-1520, MIT, Cambridge, MA 02139.)

Aug. 9–18 International Congress of Surveyors, F.I.G., Montreux, Switzerland. Sponsor, Fédération Internationale Des Geometres. (American Congress on Surveying and Mapping, 210 Little Falls Street, Falls Church, VA 22046.)

Aug. 10–14 International Conference on Basement Tectonics, Oslo, Norway. Sponsor, Norwegian Petroleum Society. (Roy H. Gabrielsen, Department of Geology, Univ. of Oslo, P.O. Box 1047, Blindern, Oslo 3 Norway; or Don L. Baars, Department of Geology, Fort Lewis College, Durango, CO 81301.)

Aug. 10–14 Water Forum '81: Technical State of the Art Exchange, San Francisco, Calif. Sponsors, American Society of Civil Engineers, Irrigation and Drainage Division, Committee on Drainage. (P. M. Meyers, 509 North Roosevelt Blvd., Apt. D-105, Falls Church, VA 22044.)

Aug. 10–19 20th General Assembly of the International Union of Radio Science, Washington, D.C. (R. Y. Dow, National Academy of Sciences, 2101 Constitution Ave., Washington, DC 20418.)

Aug. 17–28 Third Scientific Assembly of IAMAP with Extraordinary General Assembly, Hamburg, Federal Republic of Germany. (S. Ruttenburg, NCAR, P.O. Box 3000, Boulder, CO 80307.)

Aug. 17–18 Open Symposium on Mathematical Models of Radio Propagation, Washington, D.C. Sponsor, URSI. (J. R. Wait, Bldg. 20, Electrical Engineering Department, Univ. of Arizona, Tucson, AZ 85721.)

Aug. 17–22 **Ninth International Symposium on Earth Tides,** New York, N.Y. Sponsors, IAG, IUGG, Columbia Univ. (J. T. Kuo, 828 S.W. Mudd, Columbia Univ., New York, NY 10027.)

Aug. 18–21 Second Biennial Conference and Exhibition of the Australian Society of Exploration Geophysicists, Adelaide, South Australia. (J. Haigh, Conference Chairman, P.O. Box 42, Unley, South Australia 5061.)

Aug. 20–21 Second International Symposium on Computer-Aided Seismic Analysis and Discrimination, North Dartmouth, Mass. Sponsors, Electrical Engineering Department, Southeastern Massachusetts University, IEEE Computer Society, IEEE Acoustics, Speech and Signal Processing Society. (C. H. Chen, Electrical Engineering Department, Southeastern Massachusetts University, North Dartmouth, MA 02747.)

Aug. 24–26 International Symposium on Management of Geodetic Data, Copenhagen, Denmark. Sponsors, IAG, the Danish National Committee of IUGG, Geodaetisk Institut. (C. C. Tscherning, International Symposium Management of Geodetic Data, Geodaetisk Institut, Gamlehave Alle 22, Charlottenlund DK-2920 Denmark.)

Aug. 24–29 Eighth Annual Meeting of the European Geophysical Society, Uppsala, Sweden. (C.-E. Lund, Chairman Local Organizing Committee, Institute of Solid Earth Physics, Uppsala University, Box 556, 22 Uppsala, Sweden.)

Aug. 25–27 The Royal Institution of Chartered Surveyors Centenary Celebration, London, England. (Representative Radinski, American Congress on Surveying and Mapping, 210 Little Falls Street, Falls Church, VA 22046.)

Aug. 28–Sept. 9 Arc Volcanism Symposium, Tokyo, Japan. Sponsors, Volcanological Society of Japan, IAVCEI. (Daisuke Shimozuru, IAVCEI Symposium on Arc Volcanism, Earthquake Research Institute, Univ. of Tokyo, Bunkyo-ku, Tokyo 113 Japan.)

Aug. 31–Sept 2 Third International Colloquium on Mars, Pasadena, Calif. Sponsors, NASA, Lunar and Planetary Institute, Division of Planetary Sciences of the AAS. (Conway W. Snyder, Jet Propulsion Laboratory, Pasadena, CA 91109.)

Aug. 31–Sept. 5 Symposium on Geodetic Networks and Computations, Munich, West Germany. Sponsor, IAG. (Deutsche Geodätische Kommission, Bayerischen Akademie der Wissenschaften, Marstallplatz 8, D-8000 Munchen 22.)

Sept. United Nations Symposium on Water Management in Industrialized Areas, Lisbon, Portugal. (Chairman of the Executive Committee, International Symposium on Water Management in Industrial Areas, Portuguese Water Resources Association, c/o LNEC, Av. do Brasil, 101, 1799 Lisbon, Portugal.)

Sept. 7–12 Third International Symposium on Antarctic Glaciology, Columbus, Ohio. Sponsors, International Commission on Snow and Ice, International Glaciological Society. (Institute of Polar Studies, Ohio State Univ., 125 S. Oval Mall, Columbus, OH 43210.)

Sept. 8–12 American Society of Photogrammetry-American Congress on Surveying and Mapping Fall Convention, San Francisco, Calif. (L. W. Aggers, USGS, 345 Middlefield Road, Mail Stop 31, Menlo Park, CA 94025.)

Sept. 13–17 National Water Well Association 33rd Annual Convention and Groundwater Technology Education Session, Kansas City, Mo. (NWWA, 500 West Wilson Bridge Rd., Worthington, OH 43085.)

Sept. 16–18 **Oceans '81,** Boston, Mass. Sponsors, Marine Technology Society, IEEE Council of Oceanic Engineering, AGU. (R. Nagle, Publicity Manager, Raytheon Company, 141 Spring St., Lexington, MA 02173.)

Sept. 17–18 **Midwest Meeting,** Minneapolis, Minn. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

Sept. 17–18 **Pacific Northwest Regional Meeting,** Ellensburg, Wash. (Bob Bentley, PNAGU, Central Washington University, P.O. Box 1000, Department of Geology, Ellensburg, WA 98920.)

Sept. 20–22 National Water Well Association 34th Annual Convention and Exposition, Atlanta, Ga. (NWWA, 500 West Wilson Bridge Rd., Worthington, OH 43085.)

Sept. 28–Oct. 10 NATO Advanced Study Institute on Chemistry of the Unpolluted and Polluted Troposphere, Corfu, Greece. (W. Jaeschke, Center of Environmental Protection, University of Frankfurt, Robert-Mayer-Str. 11, 6000 Frankfurt/Main, FRG.)

Oct. 6–8 International Conference on Time Series Methods in Hydrosciences, Burlington, Ontario. Sponsors, National Water Research Institute of the Canada Centre for Inland Waters and Water-Resources Branch of Ontario's Ministry of Environment. (A. El-Shaarawi, Aquatic Physics and Systems Division, NWRI, Canada Centre for Inland Waters, P.O. Box 5050, Burlington, Ontario L7R 4A6 Canada.)

Oct. 7–9 John Muir Geophysical Society's Fourth Nonannual Meeting, Lake Arrowhead, Calif. (M. McNutt, USGS, Menlo Park, CA 94025.)

Oct. 11–14 Coastal Society's Seventh Annual Conference, Galveston, Tex. (N. West, Coastal Society Conference, Department of Geography and Marine Affairs, Univ. of Rhode Island, Kingston, RI 02881.)

Oct. 11–15 51st Annual International Meeting of the Society of Exploration Geophysicists, Los Angeles, Calif. (William L. Baker, Technical Program Chairman, c/o Chevron Oil Field Research Co., Box 446, La Habra, CA 90631.)

Oct. 12–16 Third International Ocean Disposal Symposium, Woods Hole, Mass. Sponsor, Office of Marine Pollution Assessment, NOAA. (I. W. Duedall, Marine Sciences Research Center, State University of New York, Stony Brook, NY 11794.)

Oct. 13–15 Fifth Geopressured-Geothermal Energy Conference, Baton Rouge, La. Sponsors, Louisiana Geological Survey, Department of Natural Resources; Energy Programs Office, Louisiana State University; U.S. Department of Energy. (Ann Bachman, Conference Coordinator, Energy Programs Office, 105 Hill Memorial, Louisiana State Univ., Baton Rouge, LA 70803.)

Oct. 13–16 Division of Planetary Sciences of the American Astronomical Society Annual Meeting, Pittsburgh, Pa. (B. Hapke, Dept. of Geology and Planetary Science, 321 Old Engineering Hall, University of Pittsburgh, Pittsburgh, PA 15260.)

Oct. 14–16 Third Surveying and Mapping Colloquium for the Petroleum Industry, Banff, Alberta, Canada. Sponsor, Canadian Petroleum Association. (Liz Hampton, Canadian Petroleum Association, 1500, 633 Sixth Ave., S.W., Calgary, Alberta, Canada T2P 2Y5.)

Oct. 19–22 Earth Impact Conference, Snowbird, Utah. Sponsors, Lunar and Planetary Institute, National Academy of Sciences. (Earth Impact Conference, Lunar and Planetary Institute, 3303 NASA Road 1, Houston, TX 77058.)

Oct. 22–24 Fourth Conference on the Physics of the Jovian and Saturnian Magnetospheres, Laurel, Md. Sponsor, NASA. (S. M. Krimigis, Applied Physics Laboratory, Johns Hopkins Univ., Laurel, MD 20810.)

Oct. 26–30 Symposium on Quaternary Land-Sea Migration Bridges and Human Occupation of Submerged Coastlines, La Jolla, Calif. Sponsors, Quaternary Shorelines Commission of the International Union for Quaternary Research, Scientific Committee of the World Confederation of Underwater Activities. (Patricia M. Masters, Scripps Institution of Oceanography, A8-012, La Jolla, CA 92093.)

Oct. 29–31 28th Annual Eastern Pacific Oceanic Conference, Idlewood, Calif. (R. Michael Laurs, EPOC Secretary, Southwest Fisheries Center, NMFS, La Jolla, CA 92037.)

November 1–6 Sixth Biennial International Estuarine Research Conference, Gleneden Beach, Oreg. Sponsor, Estuarine Research Federation. (Jay F. Watson, Treasurer, USFWS Suite 1692, 500 N.E. Multnomah Street, Portland, OR 92232.)

Nov. 2–6 International Conference on the Venus Experiment, San Francisco Bay Area, Calif. Sponsor, NASA. (Dr. Lawrence Colin, Ames Research Center, Moffett Field, CA 94035.)

Nov. 9–11 Special Conference on the Mechanical Behavior of Salt, University Park, Pa. Sponsor, Rock Mechanics Laboratory, Department of Mineral Engineering, Pennsylvania State University. (H. Reginald Hardy, Jr., Rock Mechanics Laboratory, Room 117, Mineral Sciences Building, Pennsylvania State University, University Park, PA 16802.)

Nov. 9–20 Second Symposium on Geodesy in Africa, Nairobi, Kenya. Sponsors, IAG, IUGG Local Committee of Kenya, IUGG Committee on Advice to Developing Countries, African Association of Cartography. (R. Omandi, Survey of Kenya, P.O. Box 30046, Nairobi, Kenya.)

Nov. 30–Dec. 11 43rd Session of the International Statistical Institute, Buenos Aires, Argentina. (Jim R. Wallis, IBM, Research Division, Box 218, Yorktown Heights, NY 10598; or G. S. Watson, Bernoulli Society for Mathematical Statistics and Probability, Department of Statistics, Princeton Univ., Princeton, NJ 08544.)

Dec. 3–5 **Topical Conference on the Processes of Planetary Rifting,** San Francisco, Calif. Sponsor, Lunar and Planetary Institute. (Rift Meeting, Projects Office, Lunar and Planetary Institute, 3303 NASA Road 1, Houston, TX 77058.)

Dec. 7–11 **AGU Fall Meeting,** San Francisco, Calif. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

Dec. 16–19 Annual International Meeting of the Working Group on Mediterranean Ophiolites, Florence, Italy. (Luigi Beccaluva, Istituto di Petrografia, Via Gramsci 9, 43100 Parma, Italy.)

1982

Jan. 11–14 Symposium on the Understanding of Hydrologic Processes at the Basin Scale, Caracas, Venezuela. Sponsors, Universidad Simón Bolívar, IAHS. (Ignacio Rodríguez-Iturbe, Universidad Simón Bolívar, Apartado Postal 80.659, Caracas 1081, Venezuela.)

Feb. 8–12 **Third International Geodetic Symposium on Satellite Doppler Positioning,** Las Cruces, N. Mex. Sponsors, Defense Mapping Agency, National Ocean Survey, AGU. (Richard Peat, Defense Mapping Agency, Hydrographic/Topographic Center, 6500 Brooks Lane, N.W., Washington, DC 20315.)

Feb. 16–19 **Ocean Sciences AGU/ASLO (American Society of Limnology and Oceanography) Joint Meeting,** San Antonio, Tex. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

Mar. 22–26 International Symposium on Hydrothermal Reactions, Yokohama, Japan. Sponsor, Tokyo Institute of Technology. (Shigeyuki Sōmiya, Research Laboratory of Engineering Materials, Tokyo Institute of Technology, Nagatsuta, Midori, Yokohama, 227 Japan.)

Mar. 24–27 Conference on Earthquake Hazards in the Eastern San Francisco Bay Area, Hayward, Calif. Sponsors, USGS, East Bay Council on Surveying and Mapping, Calif. Div. of Mines and Geol., Woodward-Clyde Consultants, Calif. St. Univ. at Hayward. (Sue Hirschfeld, Dept. of Geological Sciences, California State University, Hayward, CA 94542.)

Apr. 11–16 Penrose Conference on Antarctic Sedimentation, Shenandoah National Park, Va. Sponsor, GSA. (Ian W. D. Dalziel, Lamont-Doherty Geological Observatory, Columbia University, Palisades, NY 10964.)

April 19–21 Cordilleran Section, Geological Society of America and Seismological Society of America Annual Meeting, Anaheim, Calif. (Neil Maloney, Earth Science Department, California State Univ., Fullerton, CA 92634.)

April 27–29 **Chapman Conference on Rainfall Rates,** Urbana, Ill. (Meetings, AGU, 2000 Florida Avenue, N.W., Washington, DC 20009.)

May 3–7 **14th International Liège Colloquium on Ocean Hydrodynamics,** Liège, Belgium. Sponsors IAPSO, Unesco Marine Sciences Division, EGS, Intergovernmental Oceanographic, AGU. (Jacques C. J. Nihoul, University of Liège, Mécanique des Fluides Géophysiques-Environment, B6- Sart Tilman, B-4000 Liège, Belgium.)

May 7–20 General Meeting of IAG, Tokyo, Japan. (I. Nakagawa, Geophysical Institute, Kyoto University, Sakyo-ku, Kyoto 606 Japan.)

May 10–12 Fourth International Conference on Planning and Management of Water Resources for Industrial, Agricultural, and Urban Use, Marseilles, France. Sponsors, Commission Européenne Méditerranéenne de Planification des Eaux (C.E.M.P.E.), Société des Eaux de Marseille (S.E.M.), the Bureau de Recherches Géologiques et Minières (B.R.G.M.), Centre de Formation Internationale à la Gestion des Ressources en Eau (CEFIGRE), UNESCO, Commission des Communautés Européennes, Association des Hydrogéologues (AIH). (Secretariat de la Conference, Société des Eaux de Marseille, 25 rue Edouard Delanglade—13006 Marseille, France.)

May 11–22 International Solar-Terrestrial Physics Symposium, Ottawa, Ontario, Canada. (Professor Liu, University of Illinois, Urbana, IL 61801.)

May 17–June 3 24th Plenary Meeting of COSPAR, Ottawa, Ontario, Canada. (T. W. McGrath, Executive Member, Local Organizing Committee, XXIV COSPAR Conference Secretariat, National Research Council, Ottawa, Ontario K1A OR6, Canada.)

May 23–26 Eastern Conference on Water and Energy: Technical and Policy Issues, Pittsburgh, Pa. Sponsors, ASCE, League of Women Voters, Council of State Governments. (F. Kilpatrick, USGS National Center, Mail Stop 414, Reston, VA 22092.)

May 25–28 **Symposium on the Composition of Nonurban Troposphere,** Williamsburg, VA. Sponsors, AMS, NASA, AGU. (Jack Fishman, Mail Stop 401-B, NASA Langley Research Center, Hampton, VA 23665.)

May 31–June 4 **AGU Spring Meeting,** Philadelphia, Pa. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

June 15–17 International Symposium on Hydrometeorology, Denver, Colo. Sponsor, American Water Resources Association. (A. I. Johnson, Woodward-Clyde Consultants, 2909 West 7th Ave., Denver, CO 80204.)

June 15–18 **International Conference on Rainwater Cistern Systems,** Honolulu, Hawaii. Sponsors, University of Hawaii's Water Resources Research Center, AGU. (Yu-Si Fok, General Conference Chairman, Water Resources Research Center, Univ. of Hawaii, 2540 Dole Street, Honolulu, HI 96822.)

June 27–30 Western Conference on Water and Energy: Technical and Policy Issues, Fort Collins, Colo. Sponsors, ASCE, League of Women Voters, Council of State Governments. (D. Matchett, Stone and Webster Engineering Corp., P.O. Box 5406, Denver, CO 80217.)

June 27–July 2 Fifth International Conference on Geochronology, Cosmochronology, and Isotope Geology, Nikko National Park, Japan. (K. Shibata, Geological Survey of Japan, Higashi 1-1-3, Yatabe, Ibaraki 305 Japan.)

July 19–30 Scientific Meeting of IAHS with Extraordinary General Assembly, Exeter, United Kingdom. (John C. Rodda, Department of the Environment, Water Data Unit, Reading Bridge House, Reading RG1 8PS United Kingdom.)

Aug. 2–6 Joint Oceanographic Assembly, Halifax, Nova Scotia, Canada. Sponsor, Scientific Committee on Oceanic Research. (Leo O'Quinn, National Steering Committee for JOA, c/o Canadian Committee on Oceanography, 240 Sparks St., Ottawa, Ontario K1A 0E6 Canada.)

Aug. 2–6 Second International Symposium/Workshop on Solar-Terrestrial Influences on Weather and Climate, Boulder, Colo. Sponsor, Lockheed Palo Alto Research Laboratory. (Billy M. McCormac, Lockheed Palo Alto Research Laboratory, Dept. 52-13/B202, 3251 Hanover Street, Palo Alto, CA 94304.)

Aug. 15–21 Fourth International Symposium on Antarctic Earth Sciences, Ingle Farm, South Australia, Australia. Sponsors, Australian Academy of Science, Australian Academy of Technological Sciences, International Union of Geological Sciences, Scientific Committee on Antarctic Research, Geological Society of Australia, Inc., Univ. of Adelaide. (J. B. Jago, South Australian Institute of Technology, P.O. Box 1, Ingle Farm, South Australia, Australia 5098.)

Aug. 15–22 International Meeting on Generation of Major Basalt Types, Reykjavik, Iceland. Sponsors, IAVCEI, IAGC. (Basalt Meeting, c/o G. E. Sigvaldason, Nordic Volcanological Institute, 101 Reykjavik, Iceland.)

Aug. 15–22 IAVCEI and IAGC Joint Meeting, Reykjavik, Iceland. (G. E. Sigvaldason, Nordic Volcanological Institute, Univ. of Iceland, Geosciences Building, 101 Reykjavik, Iceland.)

Aug. 22–28 11th International Congress on Sedimentology, Hamilton, Ontario, Canada. Sponsor, IAS. (IAS Congress 1982, Department of Geology, McMaster University, Hamilton, Ontario L8S 4M1, Canada.)

Aug. 22–28 **Third Circum-Pacific Energy and Mineral Resources Conference,** Honolulu, Hawaii. Sponsor, IUGS. (AAPG Convention Department, P.O. Box 979, Tulsa, OK 74101.)

Aug. 23–27 Second Symposium on Applied Glaciology, Hanover, N.H. Sponsor, International Glaciology Society. (Secretary General, International Glaciological Society, Lensfield Road, Cambridge CB2 1ER, United Kingdom.)

Aug. 24–27 Ninth Annual Meeting of the European Geophysical Society, Leeds, United Kingdom. (J. C. Briden, Department of Earth Sciences, University of Leeds, Leeds LS2 9JT, England.)

Sept. 3–11 Fourth World Congress on Water Resources, Buenos Aires, Argentina. Sponsor, International Water Resources Association. (G. E. Stout, President of the U.S. Geographical Committee, Water Resources Center, University of Illinois, 2535 Hydrosystems Laboratory, 208 N. Romine, Urbana, IL 61801.)

Sept. Third International Kimberlite Conference, Clermont-Ferrand, France. (Françoise Boudier, Université de Nantes, Laboratoire de Tectonophysique, 2 Rue de la Houssiniere, 44072 Nantes, France.)

May or Sept. Scientific Meeting of IAPSO, Halifax, Canada. (E. C. LaFond, LaFond Oceanic Consultants, P.O. Box 7325, San Diego, CA 92017.)

Dec. 6–10 **AGU Fall Meeting,** San Francisco, Calif. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

1983

Feb 1–11 15th Pacific Science Congress, Dunedin, New Zealand. Sponsor, University of Otago. (Secretary-General, P.O. Box 6063, Dunedin, New Zealand.)

July 18–23 Fourth International Conference on Permafrost, Fairbanks, Alaska. Sponsors, National Academy of Sciences, State of Alaska. (L. De Goes, Polar Research Board, National Academy of Sciences, 2101 Constitution Ave., N.W., Washington, DC 20418.)

Aug. 15–26 18th General Assembly of IUGG, Hamburg, Federal Republic of Germany. (P. Melchior, Observatoire Royal de Belgique, Avenue Circulaire 3, B-1180 Bruxelles, Belgium.)

Aug. 27 Symposium Commemorating the 100th Anniversary of the Mount Krakatau Eruption, Jakarta, Indonesia. Sponsor, Indonesian Institute of Sciences. (Didin Sastrapradja, Deputy Chairman for Natural Sciences, LIPI JL, Teuku Chik Ditiro 43, Jakarta, Indonesia.)

Sept. 12–14 National Water Well Association 35th Annual Convention and Exposition, St. Louis, Mo. (NWWA, 500 West Wilson Bridge Rd., Worthington, OH 43085.)

Dec. 5–9 **AGU Fall Meeting,** San Francisco, Calif. (Meetings, AGU, 2000 Florida Ave., N.W., Washington, DC 20009.)

FUTURE AGU MEETINGS

Fall Meetings
December 7–11, 1981, San Francisco
December 6–10, 1982, San Francisco
December 5–9, 1983, San Francisco

Spring Meetings
May 31–June 4, 1982, Philadelphia

AAPG American Association of Petroleum Geologists
AMS American Meteorological Society
ASCE American Society of Chemical Engineers
GSA Geological Society of America
IAG International Association of Geodesy
IAGA International Association of Geomagnetism and Aeronomy
IAHS International Association for Hydrological Sciences
IAMAP International Association of Meteorology and Atmospheric Physics
IAPSO International Association of Physical Sciences of the Ocean
IASPEI International Association of Seismology and Physics of the Earth's Interior
IAVCEI International Association of Volcanology and Chemistry of the Earth's Interior
IUGS International Union of Geological Sciences
IWRA International Water Resources Association
MSA Mineralogical Society of America
SEG Society of Exploration Geophysicists
SEPM Society of Economic Paleontologists and Mineralogists
URSI International Union of Radio Science

GAP

Aeronomy

Electromagnetics

0780 Electromagnetic scattering
ELECTROMAGNETIC WAVE SCATTERING BY SPHEROIDAL OBJECTS USING A METHOD OF SPIN-WEIGHTED HARMONICS
J. A. H. Futterman (Center for Relativity, Department of Physics, The University of Texas at Austin, Austin, TX 78712) and R. A. Matzner
We describe a technique for calculating wave propagation adapted from the study of black hole perturbations in General Relativity, and illustrate its use by treating the scattering of plane electromagnetic radiation by perfectly conducting oblate spheroids. The technique employs expansions in terms of orthogonal functions called spin-weighted spheroidal harmonics. The advantages of the technique are that it suppresses the vectorial nature of the problem and allows for simple application of boundary conditions. A specialization to the spherical case is made in order to compare explicit analytical expressions to well-known results.
Rad. Sci., Paper 1S1064

Exploration Geophysics

0920 Magnetic and electrical methods
THE AIRBORNE ELECTROMAGNETIC DISCOVERY OF THE DETOUR ZINC-COPPER-SILVER DEPOSIT, NORTHWESTERN QUEBEC
See 9270 North America
L. E. Reed (Selco Mining Corp. Ltd., 55 University Ave., Suite 1700, Toronto, Ont., Canada M5J 2H7)
In June 1974, a diamond drill operated for Selco Mining Corp. intersected zinc-copper sulfides in Brouillan Township in northwestern Quebec. To date, two bodies have been outlined. These bodies were ...

Geochemistry

Izvestiya Atmospheric and Oceanic Physics
Volume 16, Number 8

nitrogen is in chemical equilibrium $[CH_3C(O)OONO_2 \rightleftharpoons CH_3C(O)OO + NO_2]$ with inorganic NO_2 and acts as reservoir of inorganic NO_x. Measurement methods for PAN are currently available to verify these predicted results.
Geophys. Res. Lett. Paper 1L'0'A

1460 Geochronology (age determinations by radioactive processes)
A NEW INTERPRETIVE PROCEDURE FOR WHOLE ROCK U-Pb SYSTEMS, APPLIED TO THE VREDEFORT CRUSTAL PROFILE
H. Welke (Bernard Price Institute of Geophysical Research, University of the Witwatersrand, Johannesburg, South Africa, 2000) L.O. Nicolaysen
Granulite grade PreCambrian gneisses have usually undergone at least one period of strong U depletion. Whole rock U-Pb isotope studies can determine the time(s) of the severe depletion and this work attempts to place such studies on a more rigorous footing. 2-stage U-Pb systems can be described in terms of one major, episodic differentiation into rocks with varying U/Pb ratios, while 3-stage systems can be described by two such distinct episodes. Most of the PreCambrian granulites which have been isotopically analysed have histories too complex to be described as 2-stage systems. However, it is demonstrated here that U-Pb data on whole rock suites can yield the complete U-Pb chemical history of a 3-stage system (in terms of U/Pb ratios). For a suite of granulites, present day $^{207}Pb/^{204}Pb$ and $^{206}Pb/^{204}Pb$ ratios and element concentration data allow these ratios to be calculated at a number of specific past times and plotted as an array. The degree of scatter in each of these 'past arrays' is graphed as a function of time. The point of least scatter denotes the age of the end of stage 2 in the history of the system. The array slope and the dating of the end of stage 2 also permit the beginning of stage 2 to be calculated. All other parameters in the system (U and Pb concentrations, Pb isotopic ratios) can now be determined for each individual rock throughout its history. The new interpretive method also distinguishes sensitively among various kinds of uranium fractionation which may have operated during the differentiation episodes. It is applied here to uranium-depleted granulites in the deeper part of the Vredefort crustal profile. The times of the two fractionating episodes are calculated at ~ 3860 My and ~ 2760 My respectively. The Vredefort 3070 My event – when geochemical systems in the upper half of the crystalline basement became permanently closed – evidently had little significance for the lower half of the crystalline basement. Some fundamental features of Archaean basement evolution, whose detailed significance is still poorly understood, were elucidated for the first time by this U-Pb isotope ...

1460 Geochronology (age determinations by radioactive processes)
GEOCHRONOLOGY OF THE DEEP PROFILE THROUGH ARCHEAN BASEMENT AT VREDEFORT, WITH IMPLICATIONS FOR EARLY CRUSTAL EVOLUTION

Geodesy and Gravity

1905 Artificial satellite techniques

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National Ocean Survey at an open coastal location on Bermuda to provide a determination of the instantaneous sea-surface height during the Seasat overflight of the island. The tide gage was geodetically tied to the laser tracking station on Bermuda, so that Seasat's position relative to the sea surface could be determined independently and compared with the value provided by the altimeter measurements. The root sum square (RSS) error in the determination of the vertical position of the laser, relative to the sea surface, has been estimated to be 4.0 cm, exclusive of possible errors due to lack of precise information on the elevations of the geoid at Bermuda.
J. Geophys. Res., Red, Paper 1S1008

1950 Relation of gravity observations to tectonics
GRAVITY MODEL AND STRUCTURAL IMPLICATIONS OF THE GODDARD PENDANT, SIERRA NEVADA, CALIFORNIA
Edward A. du Bray (U.S. Geological Survey, Saudi Arabian Mission, APO New York 09697)
R. W. Oliver (U.S. Geological Survey, Menlo Park, California 94025)
A subsurface model for the Goddard pendant is constructed from a residual gravity high of about 7 mgal over the pendant. The model, which is the simplest and most geologically reasonable possibility, shows a metamorphic block that tapers with depth and extends about 3.5 km below the surface. The structures in the Goddard pendant are similar in style and orientation to those in other Sierra Nevada pendants, indicating that the country rock was neither deformed nor rotated during pluton emplacement. Consequently, emplacement must have been a passive rather than a forceful process. The pendant itself represents a piece of country rock trapped between plutons which are dome shaped in cross section.
J. Geophys. Res., Red, Paper 1B0963

Geomagnetism and Paleomagnetism

2560 Time variations, paleomagnetism
PALEOMAGNETIC CORRELATION OF COLUMBIA RIVER BASALT FLOWS USING SECULAR VARIATION
S. Bogue (Earth Science Board, University of California, Santa Cruz, CA 95064) and R. Coe
A statistical method is developed to evaluate stratigraphic correlations that are based on the similarity of paleomagnetic directions. It involves comparison of the probabilities that such directions could have arisen by (1) simultaneous or (2) random samplings of the ancient magnetic field. To calculate these probabilities one must estimate the effects of paleomagnetic errors and paleosecular variation, respectively. The method is tested successfully on sections of 8–10 Columbia River Basalt (Grande Ronde) flows at Sentinel Gap and Umtanum Ridge, which are separated by only 25 km and contain two flows thought to be the same on geological grounds. More significantly, for widely separated sections at Sentinel Gap and Butler Canyon the analysis again shows that simultaneous magnetization is a much more likely explanation of the general similarity of paleomagnetic directions than chance agreement of ancient field directions. The simplest interpretation of this result is that many of the flows at the two sites are the same, implying that series of Grande Ronde flows extended over distances of several hundred kilometers. (Paleomagnetism, correlation, Columbia River Basalt, secular variation).
J. Geophys. Res., Red, Paper 1B0966

2560 Time variations, paleomagnetism
ZONAL HARMONIC MODELS OF REVERSAL TRANSITION FIELDS
I. Williams and M. Fuller (Department of Geological Sciences, University of California, Santa Barbara, CA 93106)
Synthetic reversal records for different latitudes have been generated for zonal transition fields with various zonal harmonic contents. The model fields are based upon a redistribution of energy from an exponential decay of the dipole field to ...

Soviet Hydrology
Volume 18, Number 1

Hydrology

3115 Evaporation

3150 Precipitation

3160 Runoff and streamflow

Meteorology

data remote sensing could provide. These data were used to evaluate the utility of periodic soil moisture measurements for system updating. Analyses indicated the potential value of the data and supported its evaluation on a larger scale. (Remote sensing, microwave, soil moisture)
Hydrological Sciences Bull. vol. 26, no. 3.

3100 Water quality
THE USE OF SPECIFIC CONDUCTANCE IN STUDIES OF NATURAL WATERS AND SOIL SOLUTIONS
I. D. L. Foster (Department of Geography, Coventry (Lanchester) Polytechnic, Priory Street, Coventry CV1 5FB, UK), I.C. Grieve and A. D. Christmas
Specific conductance (SC) is widely used as a measure of mineral salt concentration and a variety of models have been employed which relate SC to total dissolved solids (TDS) and individual ionic concentrations. This paper attempts to evaluate several models and highlights two major problems associated with them from analysis of water samples collected from two small catchments in East Devon and North Warwickshire. Firstly, the presence of dissolved organic material, at the levels encountered in soil solutions, may seriously affect the SC/TDS relationship and will often be an undetected component of dissolved load. Secondly, the low pH of some water samples is shown to affect those models which calculate SC on the basis of individual ionic concentrations. This results from high H^+ ion levels and associated increased solubility of other ions, such as Fe^{3+}, Al^{3+} and Mn^{2+} which are not normally determined in water quality studies. (Specific conductance, soil water)
Hydrological Sciences Bull. vol. 26, no. 3.

3725 Convection
CONVECTION IN GATE
R. A. Houze, Jr. (Department of Atmospheric Sciences, University of Washington, Seattle) A. K. Betts

3770 Particles and aerosols
LIDAR OBSERVATIONS OF VOLCANIC CLOUDS IN THE STRATOSPHERE OVER FUKUOKA, CAUSED BY ERUPTIONS OF MT.ST. HELENS IN MAY 1980
M. Hirono (Department of Physics, Kyushu University Fukuoka 812 Japan) M. Fujiwara, T. Shibata and M. Kugumiya

Sudden increase of stratospheric aerosols was observed by a Nd-YAG lidar at the wavelengths 1.064 um (F) and 0.532 um (S) since June 4,1980 (all times JST = GMT + 9). The increase is thought to be caused by the explosive eruption of Mt.St. Helens in May 1980. The initial increase began at about 15 km altitude and the scattering ratio at the wavelength F reached the maximum value on June 5. This indicates that the aerosol mixing ratio is about 20 times non-volcanic value at the same altitude. The extinction of the vertically incident direct solar radiation has been calculated to be $2x10^{-2}$ and $1.2x10^{-2}$ on the average for June and July, which are 4.6 and 3 times non-volcanic values in fall '79, respectively. After examination of the size distribution of aerosols inferred from comparison of profiles at the F and S wavelengths and with data by other measurements, it may be concluded that our lidar has seen relative time and space variations of aerosols fairly well, but a little underestimated their abundance due to the assumption of clear air at the altitude near 30 km. A plausible method of correction for the underestimation is described and the above extinction would be increased to 1.4~2 times. Global distribution of aerosol inventory is briefly estimated on the basis of the two dimensional analysis. (Volcanic ejecta, global dispersion, aerosol size, climate).
Geophys. Res. Lett., Paper 1L0817

3770 Particles and aerosols
SOUTHERN HEMISPHERE STRATOSPHERIC AEROSOL MEASUREMENTS - 3 SIZE DISTRIBUTION 1974 1979
J.L. Gras (Division of Cloud Physics, CSIRO, Sydney, Australia) Jean E Laby

The stratospheric aerosol particle size distribution has been measured at 34°S, for the period 1974-1979. Results from two measuring techniques - in-situ single-particle counting and jet impaction - agree well. The size distribution is shown to be described equally well by either a log-normal or zero-order logarithmic function. Observed distributions agree substantially with model predictions for r > 0.1 μm but indicate fewer particles at smaller radii. (Stratosphere, aerosol, southern hemisphere.)
J. Geophys. Res., Green, Paper 1C0735

Mineralogy, Petrology, and Crystal Chemistry

4260 Paragenesis, petrography and petrogenesis
[illegible] MAJOR ELEMENT VARIATIONS IN [illegible] GLASSES FROM THE MID-ATLANTIC RIDGE 29°N to 73°N
H. Sigurdsson (Graduate School of Oceanography, University of Rhode Island, Kingston, R.I. 02881, U.S.A.)

Tholeiitic glasses from 29°N to 73°N on the Mid Atlantic Ridge define two geographic and geochemical groups that are characterized by different major element concentrations [illegible]
J. Geophys. Res., Red, Paper 1B0435

4260 Paragenesis, petrography, and petrogenesis
SOLUTE PARTITIONING UNDER CONTINUOUS COOLING CONDITIONS AS A COOLING RATE INDICATOR
P.I.K. Onorato (GTE Laboratories, Waltham, MA 02154) R.W. Hopper (Lawrence Livermore Laboratories, Livermore, Cal. 94550) M. Yinnon and D.R. Uhlmann (Massachusetts Institute of Technology, Cambridge, MA 02139) and L.A. Taylor, [illegible] (University of Tennessee, Knoxville, Tennessee 37916)

A diffusional model is developed to describe the concentration profiles as a function of time of a solute dissolved in two coexisting finite phases under continuous cooling conditions. [illegible] The model is applied to the partitioning of elements between coexisting olivine and glass [illegible] A comparison is made of calculated concentration ratios [illegible] Finally, suggestions are made for other systems where the present model can be applied to estimate the thermal histories of rocks.
J. Geophys. Res., Red, Paper 1B0939

4260 Paragenesis, petrography, and petrogenesis
CONTRASTING EVOLUTION OF CALC-ALKALIC VOLCANIC AND PLUTONIC ROCKS OF WESTERN CHIHUAHUA, MEXICO
W.C. Bagby, K. L. Cameron (Board of Earth Sciences, University of California, Santa Cruz, CA 95064) and Maryellen Cameron

Two sequences of continental-arc igneous rocks occur in the Batopilas area of the Sierra Madre Occidental of north-western Mexico. The older includes late Cretaceous to (?) early Cenozoic granitoids, and the younger is a mid-Tertiary andesite to rhyolite series that is represented largely by voluminous ignimbrites. The latter sequence contains rocks varying from 54 to 78 wt. % SiO_2 whereas the granitoids have a more restricted range in SiO_2, 57 to 68 wt. %. The major element chemistry of the two sequences is generally similar; however, the older granitoids have lower Zr/Nb, and higher Nb/Y and K/Rb compared to volcanic rocks with similar SiO_2. In addition, the granitoids have generally smaller Eu anomalies, lower concentrations of REE, and higher $(Ce/Yb)_N$ (4.6-7.2 vs 3.8-4.0) than the volcanic rocks. The intermediate rocks of the two sequences, quartz diorites and andesites, had similar petrogenetic histories and both may have originated by fractionation of mantle-derived basaltic magmas. In contrast, the more silicic rocks, granodiorites on one hand and dacites and rhyolites on the other, evolved very differently. The granodiorites may have originated from a crustal source leaving a residue of amphibolite or garnet granulite, whereas the rhyolites were the product of protracted fractional crystallization of mantle-derived melts. (Mexico, granitoids, rhyolites, petrogenesis).
J. Geophys. Res., Red, Paper 1B0752

4260 Paragenesis, petrography, and petrogenesis
MANASLU LEUCOGRANITE : A COLLISION SIGNATURE OF THE HIMALAYA. A MODEL FOR ITS GENESIS AND EMPLACEMENT
P. Le Fort (Centre de Recherches Pétrographiques et Géochimiques, BP.20, 54501 Vandoeuvre-lès-Nancy, France)

The Manaslu pluton is one of the ten leucogranites that occur in the overthrusted Higher Himalaya after the Indo-Eurasian collision. Field and analytical data indicate that the underlying migmatites of the Tibetan Slab may be the place where the leucogranitic melts have generated. The Himalayan crustal thrusting of a hot Slab over a rather cold volcano-sedimentary pile (Le Fort, 1975a) provides the necessary release of fluids. They cross the M.T, induce the partial anatexis of the overheated Tibetan Slab and produce a leucogranitic magma.

The emplacement of the magma is located at first along the main disharmonic plane above the M.T. between the infrastructure and the superstructure. There it generates a convective hydrothermal system extending very far laterally according to the stratification of permeabilities. The progressive replacement of the granite proceeds as the convected fluids, including the fluids released by the saturated magma, dissolve the mainly calcareous host rocks of Tibetan sedimentaries. A frozen image of this "caving out" progression is given by the extensive network of granitic dykes outside the pluton.

The two quite independant fluid cycles of the generation and of the emplacement have been triggered or guided by the tectonics due to collision. This two-fold model, dominated by fluid activity may be of importance for other leucogranites and granites.
J. Geophys. Res., Red, Paper 1B0986

4260 Petrogenesis of granite magmas
CHEMICAL EVOLUTION OF MAGMAS IN THE PROTEROZOIC TERRANE OF THE ST. FRANCOIS MOUNTAINS, SOUTHEASTERN MISSOURI, U.S.A., PART II. TRACE ELEMENT DATA
R.L. Cullers (Department of Geology, Kansas State University, Manhattan, Kansas 66506, U.S.A.) P.J. Koch, M.E. Bickford

The St. Francois Mountains igneous complex of Proterozoic age consists of hypabyssal, granite plutons intruded into the overlying rhyolites of similar age. Melting and crystallization models of those rocks suggested by the field, petrographic, and major element contents are further refined using Rb, Ba, Sr, REE (rare-earth element), Th, Sc, and Co contents. There are two groups of relatively undifferentiated plutons associated with the Butler Hill caldera and Taum Sauk area that could have formed by partial melting of lower crustal rocks. The plutons associated with the Butler Hill Caldera (Knoblick and Silvermine granites) could have formed by about 30% aggregate melting of a quartz diorite, graywacke, or subgraywacke. The plutons associated with the Taum Sauk area could have formed by about 30% equilibrium melting of a subarkose or arkose.

More silicic rocks of the Butler Hill caldera could have formed by fractional crystallization. The Silvermine Granite is internally zoned. Crystallization of plagioclase/biotite/hornblende/magnetite/apatite/zircon/sphene in a ratio of 0.70/0.10/0.15/0.04/0.005/0.003/0.007 from the least differentiated portion of the Silvermine Granite could have formed intermediate portions of the Silvermine. Further crystallization of the Silvermine requires more biotite (Ba begins to decrease) and less hornblende, zircon, and sphene (HREE increase) to precipitate and form the most differentiated portions. Also fractional crystallization of undifferentiated Silvermine-type magmas could have produced the sequence of Butler Hill-Breadtray-Graniteville Granites as residual liquids respectively. The early crystallizing mineral assemblage is dominated by plagioclase and biotite while the late crystallizing mineral assemblage is dominated by quartz, K-feldspar, and lesser plagioclase. The Gneissoid Granite in the Hawn Park area has the mineral assemblage and composition of a cumulate derived from the Silvermine Granite-type differentiation sequence.

The associated volcanic rocks could not have formed from melts of exactly the same composition of any of the associated intrusive rocks. Rather the volcanic rocks formed from melts of slightly different chemistry.
J. Geophys. Res., Red, Paper 1B0902

4270 Properties of minerals
HIGH-PRESSURE STRUCTURAL STUDY OF DIOPSIDE
Louise Levien (Department of Earth and Space Sciences, State University of New York, Stony Brook, New York 11794) and Charles T. Prewitt

High-pressure structural studies performed on diopside at five pressures between 1 atm and 53 kbar show that the three polyhedra that comprise the structure, M(1), M(2), and Si, decrease irregularly in size. The polyhedral volumes of M(1) and M(2) both decrease approximately 5%, whereas that of Si decreases only 1%. Comparison of high-pressure structural changes of diopside and fassaite (another clinopyroxene) shows substantial differences, with diopside showing less tetrahedral and M(1) compression and more silicate-chain kinking. Unit-cell parameters of diopside change from a = 9.7456(7) Å, b = 8.9198(8) Å, c = 5.2516(5) Å and β = 105.86(1)° at 1 atm to a = 9.612(2) Å, b = 8.765(1) Å, c = 5.1953(2) Å and β = 105.32(1)° at 53.0 kbar. Increased pressure has very little effect on equivalent isotropic temperature factors. Some structural features show "inverse" behavior with unit-cell volume changes caused by P or T (<M(1)-O>, <M(2)-O>, O(3)-Si-O(3), and O(3)-O(3)-O(3)), whereas others do not (the β cell parameter and <Si-O>). The bulk modulus and its pressure derivative, calculated from a weighted fit of the P-V data to the Birch-Murnaghan equation of state, are 1.14(4) Mbar and 4.5(1.8), respectively. The compressibility of the structure is controlled by certain M(1) and M(2) bonds. The rigid M-O bonds run parallel to the least compressible direction (ϵ_3), and the most compressible (the M-O bonds run ⊥ to ϵ_3 and approximately 45° between the two most compressible directions, ϵ_1 and ϵ_2. (Diopside, diamond-cell, crystal structure, elasticity).
Am. Mineralogist, 66, 3-4

4270 Properties of minerals
QUARTZ WITH RHOMBOHEDRAL CLEAVAGE FROM MADAGASCAR
O.W. Flörke (Institut für Mineralogie, Ruhr-Universität, 4630 Bochum, Germany) H. Kulke, H.G. Mielke and J. Reichert

Anhedral quartz slabs from a vein deposit in Madagascar showing smooth cleavage planes parallel to positive rhombohedra r{10$\bar{1}$1} are described. Only two of the three equivalent pairs of the form {10$\bar{1}$1} show cleavage, although of different quality (smoothness). The best developed planes lie parallel to Brazil-twin lamellae, the less well developed planes do not. We presume small tectonically induced thermal shocks to be the releasing mechanism for rhombohedral cleavage fractures. In combination with hydrolytic weakening and directed stress, large smooth cleavage planes were formed. Since the r-faces of quartz are F-faces, they have a minimum of free surface energy. We assume this to be the reason for cleavage parallel to positive rhombohedral faces. (Quartz, NE-Madagascar, vein deposit, rhombohedral cleavage, structure and strength).
Am. Mineralogist, 66, 5-6

4270 Properties of minerals
HIGH-PRESSURE CRYSTAL STRUCTURE AND COMPRESSIBILITY OF COESITE
Louise Levien (Department of Earth and Space Sciences, State University of New York, Stony Brook, New York 11794) and Charles T. Prewitt

Unit-cell and crystal structure parameters have been measured on a coesite single crystal at six pressures. Unit-cell parameters of coesite change from a = 7.1356(3) Å, b = 12.3692(8) Å, c = 7.1736(3) Å and β = 120.34(02)° at 1 atm to a = 6.9897(4) Å, b = 12.233(2) Å, c = 7.1112(4) Å and β = 120.74(03)° at 51.9 kbar. Both silicate tetrahedra compress significantly but do not distort over the 52 kbar pressure range. All unconstrained Si-O-Si angles and Si···Si distances decrease over the pressure range, with smaller angles and distances decreasing more than larger ones. Values for the bulk modulus $[K_T = 0.96(3)$ Mbar] and its pressure derivative $[K_T' = 8.4(1.9)]$ have been calculated by fitting the P-V data to a Birch-Murnaghan equation of state. The compressibility of the coesite structure is highly anisotropic with the stiffest direction parallel to the chains of tetrahedra, which run ∥ to a, and the most flexible direction ⊥ to these chains in the a-c plane. The criss-crossing of silicate tetrahedral chains in the a-b planes, at different levels along c, gives b an intermediate compressibility.

The increasing temperature factor of O(1), the central anion in the 180° Si-O-Si angle, suggests that this angle becomes unstable at high pressures. Because substitution of Ge for Si has a similar effect on the structure as does increased pressure, GeO_2 may not exist in the coesite structure because the 180° Ge-O-Ge angle destabilizes the structure. (Coesite, diamond-cell, crystal structure, elasticity).
Am. Mineralogist, 66, 3-4

4290 Instruments and techniques
QUANTITATIVE METHODS FOR ELECTRON MICROPROBE ANALYSIS OF SODIUM IN NATURAL AND SYNTHETIC GLASSES
C. H. Nielsen (JEOL U.S.A., INC., 11 Dearborn Road, Peabody, MA 01960) and H. Sigurdsson

Two methods have been developed for the microprobe analysis of sodium in natural and synthetic glasses that exhibit time-dependent element migration during electron bombardment. A cryogenic method is based on the cooling of the sample to -90 degrees C, when sodium diffusion rate is near zero. An empirical correction method determines the shape of the decay curve as a function of time during electron bombardment, which under normal operating conditions, gives initial sodium concentration by extrapolation. (EPMA, Obsidian glass, cryogenic techniques, Alkali diffusion, sodium loss).
Am. Mineralogist, 66, 5-6

Oceanography

4765 Surface waves, tides and sea level
TIDAL ANALYSIS OF INTERMITTENT ACOUSTIC OBSERVATIONS
B. Zetler (Scripps Institution of Oceanography, La Jolla, California 92093)

Intermittent data from acoustic transmissions (hourly or bi-hourly every third day) to be obtained in an acoustic tomography experiment in 1981 will be analyzed for tides so that the tidal effect can be removed. Two methods of analyzing the tides (1) tidal interpolation across 75 hours to patch the series, followed by response analysis, and (2) harmonic analysis with corrections for interference by nearby constituents, have been tested with a real set of acoustic extended phase data. The results by the two methods are found to be consistent and adequate. (Underwater sound, tides).
Geophys. Res. Lett., Paper 1L0329

4765 Surface waves, tides and sea level
MEASURED INFRARED RADIANCES NEAR SEA HORIZON AND THEIR INTERPRETATION - PRELIMINARY RESULTS
A. Ben-Shalom (Tel Aviv University, Department of Geophysics and Planetary Sciences, Ramat Aviv, Israel) J. Otterman and P. Schechner

The spectral radiances at wavelengths 7.8 - 11.5 μm of the sea surface at small angles below the horizon show a well defined minimum. The location of the minimum, its sharpness and its magnitude depend on wavelength, sea state, atmospheric turbidity, sea and air temperatures. Remote sensing of sea state appears possible by interpreting spectral radiances measured in a vertical scan of the sea near the horizon. A close proximity of the minimum to the horizon indicates a high sea state.
Geophys. Res. Lett., Paper 1L0364

4790 Instruments and techniques
APPLICATION OF GOES VISIBLE-INFRARED DATA TO QUANTIFYING MESOSCALE OCEAN SURFACE TEMPERATURES
G. Maul (National Oceanic and Atmospheric Administration, Atlantic Oceanographic and Meteorological Laboratories, 4301 Rickenbacker Causeway, Miami, Florida 33149)

Application of GOES archived data to determining sea surface temperature in the Gulf of Mexico is investigated for October 1977, a period when two research ships and three environmental buoys were available to provide surface calibration data. A theoretical error analysis is first used to explain the persistent differences between ship and operationally-derived satellite temperatures, and then is used to dictate a technique for applying full resolution archived GOES visible and infrared data to the problem. The technique developed first remaps the satellite scanline data into a rectangular matrix which covers the region of interest. Second, radiative transfer calculations are performed at each "cloud-free" station around the Gulf's periphery using LOWTRAN-4. Third, least squares polynomial surfaces of atmospheric corrections are fitted to the perimetric radiative transfer results. Fourth, a bivariate Bayesian discriminant function, which uses cloud-free areas as training sets, is used to objectively classify clear ocean radiance measurements. Fifth, the GOES is calibrated by comparing in situ measurements with calculated theoretical satellite temperatures. Sixth, maps of sea surface temperature are produced and compared with ship reports and a marine atlas. RMS calibration errors of GOES surface temperature determined by the above outlined approach was ± 1.7K when using all available surface reports, and ± 0.8K when using only research ship, XBT, and environmental buoy reports. Evaluation of the infrared multispectral approach planned for NOAA-C, shows that for a mesoscale area the two techniques result in similar errors, and that ± 1.0K or slightly less is probably the geophysical limit of accuracy.
J. Geophys. Res., Green, Paper 1C0714

4799 General or miscellaneous
COASTAL SUBMARINE HYDROTHERMAL ACTIVITY OFF NORTHERN BAJA CALIFORNIA-PART II: EVOLUTIONARY HISTORY AND ISOTOPE GEOCHEMISTRY
V.M.V.Vidal (Instituto de Investigaciones Eléctricas, Apartado Postal 475, Cuernavaca, Morelos, México) F.V.Vidal, J.D.Isaacs

A geochemical model of the Punta Banda submarine hydrothermal system (PBSHS) and Ensenada quadrangle subaerial hot springs is developed using $^{18}O/^{16}O$, D/H, $^{34}S/^{32}S$, ^{3}H, water and gas chemistry. The PBSHS water is a primary high temperature, acid, reducing reaction fluid of old seawater origin which has been titrated by cold, alkaline, groundwater of meteoric origin. The final exiting end member solutions represent a 1:1 mixture of the two primary mixing components. In contrast, the subaerial hot spring waters are pure meteoric water. The subaerial hot spring gas is predominantly atmospheric N_2 while the PBSHS contains large amounts of CH_4 and N_2 derived from trapped marine sediments of Cretaceous age. $\delta^{34}S$ values of sampled hydrothermal waters are similar to Cretaceous marine sulfate values and suggest the waters contacted Cretaceous marine sedimentary strata. The presence of the Alisitos and Rosario marine sedimentary formations of Cretaceous age within the Ensenada-Punta Banda quadrangles renders support to this hypothesis. The data also demonstrates that pyrite mineralization and deposition in submarine hydrothermal environments results from the complexing of ferrous iron with elemental sulfur and sulfide; and that submarine hydrothermal activity acts as a major source of silica, Ca^{2+} and trace metals and as a major sink for seawater Mg^{2+} and SO_4^{2-}. (Submarine hydrothermal activity, geochemistry, isotopes, evolution).
J. Geophys. Res., Red, Paper 1B1051

Particles and Fields—Interplanetary Space

5310 Cosmic rays
CORRELATION OF THE COSMIC-RAY INTENSITY WITH SOLAR-TERRESTRIAL PARAMETERS
J. R. Jokipii (Department of Planetary Sciences and Astronomy, University of Arizona, Tucson, Az 85721)

Shea and Smart (1981) have shown that the correlation between the Mt. Washington neutron monitor counting rate and the geomagnetic aa index changes significantly from the eleven-year period centered on one solar minimum to the next such period. They suggested that this may be a manifestation of cosmic-ray drift in the interplanetary magnetic field. This Letter reports the results of numerical simulations of cosmic-ray modulation, including drift, which verify that drifts can indeed produce the sense of the observed effect. Perturbations in the heliospheric equatorial regions affect galactic cosmic rays observed near the equator more effectively if the northern hemisphere heliospheric magnetic field is inward than if it is outward. Perturbations in K_p are substantially more effective than perturbations in the solar wind velocity or in K_p. (Drift, turbulence, geomagnetic indices).
Geophys. Res. Lett., Paper 1L0870

5310 Cosmic Rays
ENHANCED COSMIC RAY ANISOTROPIES AND THE EXTENDED SOLAR MAGNETIC FIELD
D.B. Swinson (Department of Physics and Astronomy, The University of New Mexico, Albuquerque, New Mexico 87131) T. Saito and S. Mori

Saito's two hemisphere model for the three-dimensional magnetic structure of the inner heliomagnetosphere is used to determine the orientation of the two solar magnetic hemispheres. This orientation, as viewed from the earth, varies throughout the year. The orientations during 1974 are presented, and are confirmed by satellite data for the interplanetary magnetic field. These data suggest a role for the field component perpendicular to the ecliptic plane, B_z, in giving rise to cosmic ray anisotropies detected at the earth. It is shown that an enhanced solar diurnal variation in cosmic ray intensity at the earth can arise from the constructive interference of three cosmic ray anisotropies, two of which depend on the direction of the interplanetary magnetic field. This is demonstrated using cosmic ray data from the Nagoya muon telescope, and underground muon telescopes in Bolivia, Embudo and Socorro. (Cosmic rays, solar and interplanetary magnetic field).
J. Geophys. Res., Blue, Paper 1A0985

5330 Electromagnetic radiation
A SEARCH FOR INTERPLANETARY He II, 304 Å EMISSION
F. Paresce (Space Sciences Laboratory, University of California, Berkeley, CA 94720), H. Fahr and G. Lay

A region of the sky around the antisolar direction in the Earth's shadow was systematically surveyed for the first time at high sensitivity and angular resolution by the extreme ultraviolet telescope on the Apollo-Soyuz mission. The signal from the 170-620 Å channel of the instrument, which is sensitive primarily to the He II, 304 Å and He I, 584 Å resonance lines, shows a sharp decrease in intensity as the line of sight sweeps into the shadow region. Once the line of sight is completely contained within the shadow, a small residual signal above instrumental background and independent of view direction and spacecraft position is observed. Its intensity is consistent with the expected signal from the interplanetary He I, 584 Å emission measured by the 500-780 Å channel of the extreme ultraviolet telescope. An upper limit at the 2σ confidence level to a possible He II, 304 Å component that can escape detection by our instrument corresponds to 0.02 Rayleighs (1.6×10^3 photons cm^{-2} s^{-1} sr^{-1}) or to a column density of 10^9 ions cm^{-2} scattering at line center. This flux could conceivably be generated by a number of emission sources whose characteristics we investigate in detail. We find that the two mechanisms most likely to approach the observed limit are multiple scattering of solar radiation by He^+ in the plasmasphere and resonance scattering of sunlight by interplanetary He^+ produced by photoionization of interstellar neutral He. For the latter source, our upper limit can be used to set an upper limit of 10^9 sec to the e-folding time for the decrease of the suprathermal He^+ velocity towards the bulk solar wind speed if line radiation dominates the solar continuum. If the opposite is true, the upper limit becomes 10^7 sec. These high values conflict with commonly believed theories of the underlying relaxation process and thus a drastic revision would be required if a 304 Å intensity of 0.02 R is confirmed as due to this source.
J. Geophys. Res., Blue, Paper 1A0874

5360 Solar wind interaction with moon and planets
THE DISTANT BOW SHOCK AND MAGNETOTAIL OF VENUS: MAGNETIC FIELD AND PLASMA WAVE OBSERVATIONS
C.T. Russell (Institute of Geophysics and Planetary Physics, University of California, Los Angeles, California 90024) J.G. Luhmann, R.C. Elphic and F.L. Scarf

An examination of the magnetic field and plasma wave data obtained by the Pioneer Venus orbiter in the wake region behind Venus discloses a well developed bow shock whose location is similar to that observed on previous missions in contrast to the dayside bow shock. Venus also has a well developed magnetotail in which the field strength is enhanced over magnetosheath values and in which the magnetic field is aligned approximately with the solar wind direction. The boundary between magnetosheath and magnetotail is also marked by a change in the plasma wave spectrum. (Venus, solar wind interaction, comets, magnetotail, bow shock).
Geophys. Res. Lett., Paper 1L0816

5370 Solar wind magnetic fields
DP SECTOR EFFECTS ON THE POLAR GEOMAGNETIC FIELD IN WINTER
S. Matsushita (High Altitude Observatory, NCAR, Boulder, Colorado 80307) and W.-Y. Xu

DP sector effects on the polar geomagnetic field, particularly in winter, are examined with a use of [illegible] high-latitude geomagnetic stations [illegible]
J. Geophys. Res., Blue, Paper 1A0875

5370 Solar wind magnetic fields
PROPERTIES OF WHISTLER-MODE WAVES BETWEEN 0.3 AND 1.0 AU FROM HELIOS OBSERVATIONS
H.J. Beinroth (Institut für Geophysik und Meteorologie der Technischen Universität Braunschweig, D-3300 Braunschweig, Germany) and F.M. Neubauer

A study of magnetic fluctuations in the solar wind in the distance range from 0.3 to 1 AU and the frequency range 4.7 Hz - 2.2 kHz by the Technical University of Braunschweig search-coil magnetometer experiment onboard Helios 1 and 2 during the time intervals from December 1974 to April 1975 for Helios 1 and January 1976 to May 1976 for Helios 2 yields the following results:

1.) Near 1 AU electromagnetic wave modes are restricted to frequencies less than 120 Hz for 99% of the time. Inside 0.5 AU the waves are restricted to less than 470 Hz in 94% of all cases.
2.) For a spectral density $P(f) \sim f^{\alpha}$ with the quantity P measured in nT^2/Hz the spectral index α varies between -1.4 and -2.0 with a most probable value of -1.7 and a slight tendency towards a steeper spectra towards the sun.
3.) No clear correlation between simple plasma parameters and magnetic field magnitude F on one side and spectral densities on the other side is found. The proportionality between spectral density and F is simply attributed to the radial variation.
4.) High wave intensities occur in the vicinity of stream interfaces with a decrease in wave intensity with increasing distance from the stream interaction region.
5.) Magnetic field energy density above 4.7 Hz varies between $5x10^{-18}$ erg/cm³ and 10^{-14} erg/cm³ with a maximum of occurrence of $5x10^{-17}$ erg/cm³ near 1 AU and $1.6x10^{-15}$ erg/cm³ near 0.3 AU. The values are therefore orders of magnitude below the total magnetic field energy density.
6.) The fluctuations are tentatively interpreted as locally generated whistler waves. (Solar wind, magnetic spectra, whistler-mode waves).

J. Geophys. Res., Blue, Paper 1A0882

5380 Solar wind plasma
[illegible] IN HIGH SPEED SOLAR WIND STREAMS, 2. TEMPERATURES AND BULK VELOCITIES
[illegible] and E. C. Roelof (Applied Physics Laboratory, The Johns Hopkins University, Laurel, Maryland 20810) [illegible]

[illegible]
J. Geophys. Res., Blue, Paper [illegible]

5380 Solar wind plasma
TEMPERATURE ANISOTROPY INSTABILITIES DRIVEN BY [illegible]
[illegible] (NASA/Goddard Space Flight Center, Laboratory for Extraterrestrial Physics, Greenbelt, MD 20771)

[illegible]
J. Geophys. Res., Blue, Paper 1A0743

5380 Solar wind plasma
MULTI-SPACECRAFT OBSERVATIONS OF HELIOGRAPHIC LATITUDE-LONGITUDE STRUCTURE IN THE SOLAR WIND
[illegible] (Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91103)

[illegible]
J. Geophys. Res., Blue, Paper [illegible]

Particles and Fields—Ionosphere

5505 Airglow
OBSERVATIONS OF THE Ca^+ TWILIGHT AIRGLOW FROM INTERMEDIATE LAYERS OF IONIZATION
C. A. Tepley (Space Physics Research Laboratory, Department of Atmospheric and Oceanic Science, University of Michigan, Ann Arbor, MI 48109) J. D. Meriwether, Jr., and J. C. G. Walker

[illegible]
J. Geophys. Res., Blue, Paper [illegible]

5615 Auroras
ACCELERATION OF HEAVY IONS ON AURORAL FIELD LINES
M. Ashour-Abdalla (Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90024), H. Okuda and C.Z. Cheng

[illegible]
Geophys. Res. Lett., Paper [illegible]

5530 High-latitude ionospheric currents
FIELD-ALIGNED CURRENTS AND THE STRUCTURE OF THE AURORAL ZONE IONOSPHERE
A. Hruška (Herzberg Institute of Astrophysics, National Research Council of Canada, Ottawa, Canada K1A 0R6)

[illegible]
J. Geophys. Res., Blue, Paper 1A0954

5530 High-latitude ionospheric currents
DISTANT MAGNETIC FIELD EFFECTS ASSOCIATED WITH BIRKELAND CURRENTS [illegible]
[illegible] T. A. Potemra [illegible] (The Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland 20810) [illegible]

[illegible]
J. Geophys. Res., Blue, Paper 1A1034

5550 Low-latitude ionospheric currents
5-50 METERS WAVELENGTH PLASMA INSTABILITIES IN THE EQUATORIAL ELECTROJET 3. COUNTER-ELECTROJET CONDITIONS
C. Hanuise and M. Crochet (Laboratoire de Sondages Electromagnétiques de l'Environnement Terrestre, Université de Toulon et du Var [illegible])

[illegible]
J. Geophys. Res., Blue, Paper 1A0878

5560 Particle Precipitation
NIGHTTIME OBSERVATIONS OF 0.2-26 KEV ELECTRONS IN THE SOUTH ATLANTIC ANOMALY MADE BY ATMOSPHERE EXPLORER-C
[illegible]

[illegible]
J. Geophys. Res., Blue, Paper [illegible]

Izvestiya Physics of the Solid Earth
Volume 16, Number 2

CONTENTS

[illegible]
J. Geophys. Res., Blue, Paper [illegible]

5599 Instruments and techniques
ELECTRON TEMPERATURE MEASUREMENTS BY THE PLASMA LINE TECHNIQUE AT THE FRENCH INCOHERENT SCATTER RADAR FACILITIES
[illegible] and P. Bauer

[illegible]
J. Geophys. Res., Blue, Paper 1A1073

5715 Electric fields
[illegible]

5735 Electric fields
DEPENDENCE OF POLAR-CAP POTENTIAL DROP ON INTERPLANETARY PARAMETERS
P. H. Reiff (Dept. of Space Physics & Astronomy, Rice University, Houston, Texas 77001) R. W. Spiro and T. W. Hill

We have computed the convection potential drop across the polar cap from data obtained on high-inclination low-altitude satellites (AE-C, AE-D, S3-3) and correlated these potential measurements with various combinations of parameters measured simultaneously in the upstream solar wind. [illegible]
J. Geophys. Res., Blue, Paper [illegible]

Particles and Fields—Magnetosphere

5705 Bow shock waves
UPSTREAM ENERGETIC IONS AND ELECTRONS: BOW SHOCK ASSOCIATED OR MAGNETOSPHERIC ORIGIN?
M. Scholer (Max-Planck-Institut für Extraterrestrische Physik, 8046 Garching, W.-Germany) [illegible]

[illegible]
J. Geophys. Res., Blue, Paper [illegible]

5730 Solar wind magnetic fields
THE CORONAL AND INTERPLANETARY CURRENT SHEET IN EARLY 1976
L. F. Burlaga (Goddard Space Flight Center, Laboratory for Extraterrestrial Physics, Greenbelt, MD 20771) [illegible]

[illegible]
J. Geophys. Res., Blue, Paper [illegible]

5735 Magnetopause
ISEE-1, -2 AND -3 OBSERVATION OF THE INTERACTION BETWEEN AN INTERPLANETARY SHOCK AND THE EARTH'S MAGNETOSPHERE: A RAPID TRAVERSAL OF THE MAGNETOPAUSE
[illegible] (Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA) [illegible] C.T. Russell [illegible]

The interaction between an interplanetary shock and the earth's magnetosphere was observed by ISEE-1 and -2 on January 13, 1978. [illegible]
J. Geophys. Res., Blue, Paper [illegible]

5733 Magnetopause
EVIDENCE FOR MAGNETIC FIELD RECONNECTION AT THE EARTH'S MAGNETOPAUSE
B.U.O. Sonnerup (Dartmouth College, Hanover, N.H. 03755), G. Paschmann, I. Papamastorakis, N. Sckopke, G. Haerendel, S.J. Bame, J.R. Asbridge, J.T. Gosling, and C.T. Russell

[illegible]

J. Geophys. Res., Blue, Paper 1A0941

5755 Plasma instabilities
NUMERICAL STUDY OF EXPLOSIVE TEARING MODE INSTABILITY IN ONE-COMPONENT PLASMAS
T. Yanagawa (Institute of Space and Astronautical Science, Tokyo, Japan)

[illegible]

J. Geophys. Res., Blue, Paper 1A0919

5755 Plasma instability
LOWER-HYBRID-DRIFT INSTABILITY AND ITS ASSOCIATED ANOMALOUS RESISTIVITY IN THE NEUTRAL SHEET OF EARTH'S MAGNETOTAIL

[illegible]

J. Geophys. Res., Blue, Paper 1A0973

5760 Plasma motion, convection or circulation
THREE-DIMENSIONAL COMPUTER MODELLING OF DYNAMIC RECONNECTION IN THE GEOMAGNETIC TAIL

[illegible]

J. Geophys. Res., Blue, Paper 1A10...

5760 Plasma motion, convection, or circulation
CORONATING MAGNETOSPHERIC CONVECTION

[illegible]

J. Geophys. Res., Blue, Paper 1A0645

5760 Plasma motion, convection, or circulation
ON THE INJECTION AND SCATTERING OF PROTONS IN JUPITER'S MAGNETOSPHERE

[illegible]

J. Geophys. Res., Blue, Paper 1A0890

5760 Plasma motion, convection, or circulation
OBSERVATIONS OF FIELD ALIGNED ION AND ELECTRON BEAMS FROM SCATHA (P78-2)

[illegible]

J. Geophys. Res., Blue, Paper 1A1025

5760 Plasma motion, convection, or circulation
THE DUALITY OF THE MAGNETIC-FLUX-TUBE AND ELECTRIC CURRENT DESCRIPTIONS OF MAGNETOSPHERIC PLASMA AND ENERGY FLOW

[illegible]

J. Geophys. Res., Blue, Paper 1A0651

5770 Short-period (less than 1 day) variations of magnetic field

[illegible]

J. Geophys. Res., Red, Paper 1B0860

5770 Short-period (less than 1 day) variations of magnetic field

[illegible]

J. Geophys. Res., Blue, Paper 1A...

5780 Wave propagation
SIMULTANEOUS GROUND-SATELLITE OBSERVATIONS OF QUASI-PERIODIC (QP) ELF-VLF EMISSIONS NEAR L=6

[illegible]

5799 General (Spacecraft Charging)
OBSERVATIONS OF DIFFERENTIAL CHARGING EFFECTS ON ATS-6

[illegible]

Physical Properties of Rocks

5110 Elasticity, fracture, and flow
POTENTIAL FOR GEOPHYSICAL EXPERIMENTS IN LARGE SCALE TESTS

[illegible]

5110 Elasticity, fracture and flow

[illegible]

5110 Elasticity, fracture and flow
SOME SIZE DEPENDENT PROPERTIES OF JOINTS AND FAULTS

[illegible]

J. Geophys. Res., Blue, Paper 1A1043

5120 Equations of State

[illegible]

6140 Magnetic and electrical properties
ELECTRICAL RESISTIVITY OF MINERALS AND ROCKS AT HIGH THERMODYNAMIC PARAMETERS

[illegible]

Rev. Geophys. Space Phys., Paper 1R0279

6180 Thermal properties
THE TEMPERATURE STABILIZATION OF A BOREHOLE

[illegible]

GEOPHYSICS, vol. 46, no. 9

6190 Instruments and Techniques
SIZE EFFECT IN ROCK TESTING

[illegible]

Geophys. Res. Lett., Paper 1L0677

Planetology

6510 Atmospheres of planets

[illegible]

Geophys. Res. Lett., Paper 1L0937

6510 Atmospheres of planets
CHARGE EXCHANGE IN THE VENUS IONOSPHERE AS THE SOURCE OF THE HOT EXOSPHERIC HYDROGEN

[illegible]

J. Geophys. Res., Blue, Paper 1A0953

6510 Atmospheres of planets

[illegible]

J. Geophys. Res., Blue, Paper 1A1043

6510 Atmospheres of planets

[illegible]

6510 Atmospheres of planets
LOCAL MARS DUST STORM GENERATION MECHANISM
J. A. Ryan (Earth Science Department, California State University, Fullerton, Fullerton, CA 92634), E. D. Sharman and R. D. Lucich
On $L_s = 360°$, first Mars year of Viking on the surface, a local dust storm was observed at the Viking Lander #1 site by Viking Orbiter A. The storm lasted less than one martian day (sol) with the dust raised affecting the site for about three sols. It is concluded that this storm was caused by baroclinic waves and that the threshold wind speed for saltation was 25-30 m sec^{-1}
Geophys. Res. Lett., Paper 1L0936

6510 Atmospheres of planets
THE CARBON MONOXIDE FOURTH POSITIVE BANDS IN THE VENUS DAYGLOW I: SYNTHETIC SPECTRA
Samuel T. Durrance (Laboratory for Atmospheric and Space Physics, University of Colorado, Boulder, CO 80309; present address: Physics Department, The Johns Hopkins University, Baltimore, MD 21218)
Spectral observations of the Venus dayglow from 1200-1800 Å were made with the Pioneer Venus ultraviolet spectrometer (13Å resolution), a sounding rocket telescope and spectrometer (4 Å resolution), and the International Ultraviolet Explorer (0.4 Å resolution). Emissions due to HI, CI, OI, and the CO fourth positive system are identified. Emission rate factors for the fourth positive system are calculated using a high-resolution solar flux. The importance of solar emission line excitation to this fluorescence spectrum is shown. In particular, several bands of the v' = 14 progression are identified and their excitation mechanism is shown to be fluorescent scattering of solar Lyman-α radiation. The CO (14,5) band at 1392 Å is a prominent unblended spectral feature in the Venus dayglow. The (14,3) and (14,4) bands at 1317 and 1354 Å are blended with the OI 1304 and 1356 Å features in lower resolution spectra. This identification resolves the problem of the interpretation of the ratio of the OI 1304/1356 Å emissions from Venus. It also provides an additional remote sensing technique to determine the density distribution of CO in the upper atmosphere of Venus. (Airglow, carbon monoxide, ultraviolet spectrum).
J. Geophys. Res., Blue, Paper 1A1033

6560 Interior of moon
LUNAR FLOOR-FRACTURED CRATERS: EVIDENCE FOR VISCOUS RELAXATION OF CRATER TOPOGRAPHY
J. Lynn Hall and Sean C. Solomon (Department of Earth and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA 02139) and James W. Head
In this paper we evaluate quantitatively the hypothesis that topographic modification of floor-fractured craters on the moon was accomplished predominantly by viscous relaxation. Using the simple assumption that the moon may be modeled as having a uniform Newtonian viscosity, we compare the observed topographic profiles for a number of floor-fractured craters with the profiles predicted from the viscous relaxation of topography of fresh craters of similar diameter. Despite the simplicity of the rheological model, the comparison is quite good. The floor uplift, the rim subsidence, and the apparent subsidence outside the rim for the several floor-fractured craters considered are well matched by the viscous relaxation hypothesis. Floor fractures, while indicating that a purely viscous model is not strictly valid, can be explained by the effects of isostatic adjustment on the thin brittle lithosphere. The association of many floor-fractured craters with impact basins and with the time of mare volcanism can be understood in terms of a pronounced acceleration of crater relaxation in local regions of anomalously high subsurface temperatures and therefore of low effective viscosity and thin lithosphere. The quantitative extent of relaxation of floor-fractured craters can be interpreted in terms of a limited time interval of substantial relaxation for each crater. That time interval ended for each crater after local cooling had been sufficient for the viscosity to rise, the lithosphere to thicken, and the present topographic relief to be 'frozen in'. Thus viscous relaxation is a viable hypothesis to explain the topographic profiles of a number of lunar floor-fractured craters, and the extent of viscous relaxation of crater topography may serve as a tool to map lateral and temporal variations in the shallow thermal structure of the moon and of other planets and satellites. (Moon, craters, viscosity, tectonics.)
J. Geophys. Res., Red, Paper 1B1048

6575 Surface of planets LIMITS ON LARGE-CRATER PRODUCTION AND OBLITERATION ON CALLISTO
Alex Woronow and Robert G. Strom (Lunar & Planetary Lab, University of Arizona, Tucson, Arizona 85721)
Monte Carlo simulations using the lunar highlands' crater production function and allowing enough relaxation of the large craters to evolve the size-frequency distribution of craters on Callisto results in an areal distribution of those craters unlike that actually observed on Callisto. The simulations show that if crater relaxation was as extensive as required to produce the Callisto craters from the lunar production function, then the craters on Callisto should frequently occur in clusters between the sites of the the large, relaxed craters, and expanses of lightly cratered terrain would mark the sites of the now relaxed craters. Because this is not observed on Callisto, the lunar highlands' production function is not appropriate to Callisto, and crater relaxation has not been as extensive as frequently presumed. (Callisto, Ganymede, cratering, crater relaxation, Monte Carlo simulation).
Geophys. Res. Lett., Paper 1L0884

Seismology

6925 Phenomena related to earthquake prediction
THE APPLICATION OF GEOCHEMICAL METHODS IN EARTHQUAKE PREDICTION IN CHINA
Jiang Fong-liang (W.K. Kellogg Rad. Lab., Caltech, Pasadena, CA 91125) and Li Gui-ru
Several geochemical anomalies were observed before the Haicheng, Longling, Tangshan, and Songpan earthquakes and their strong aftershocks. They included changes in groundwater radon levels; chemical composition of the groundwater (concentration of Ca^{++}, Mg^{++}, Cl^-, $SO_4^=$, and other ions); conductivity; and dissolved gases such as H_2, CO_2, etc. In addition, anomalous changes in water color and quality were observed before these large earthquakes. Before some events gases escaped from the surface, and there were reports of "ground odors" being smelled by local residents. The large amount of radon data can be grouped into long-term and short-term anomalies. The long-term anomalies have a radon emission build up time of from a few months to more than a year. The short-term anomalies have durations from a few hours or less to a few months. (Earthquake prediction, radon monitoring, geochemical monitoring).
Geophys. Res. Lett., Paper 1L0589

6953 Seismic sources
FOCAL DEPTHS AND MOMENT TENSOR REPRESENTATIONS OF SHALLOW EARTHQUAKES ASSOCIATED WITH THE GREAT SUMBA EARTHQUAKE
T. J. Fitch (MIT Lincoln Laboratory, 42 Carleton Street, Cambridge, MA 02142)
R. G. North and M. W. Shields
Focal depths in the range 8 to 24 km below the sea floor were determined for 7 of the larger shocks associated with the Great Sumba earthquake of 19 August 1977. Depth control was achieved by modelling digitized long period P-waves recorded by the WWSSN. If the base of the rupture at the time of the mainshock were no greater than the depth of the deepest aftershock the stress drop would be nearly 500 bars. Amplitude and first motion data from the P-waves were inverted for point source moment tensors. The inversion of Rayleigh and Love wave spectra computed from digital seismograms recorded by the SRO's and ASRO's broadened the source study to include earthquakes with moments as small as 10^{24} dyne-cm; too small for either traditional first motion solutions or P-wave modelling. The inversion procedure was applied to data in the pass band from 30 to 120 sec. The propagation phase for the Love and the Rayleigh waves was calibrated with signals from two earthquakes for which the source phase was inferred from the P-wave solutions. Agreement with the corresponding P-wave solutions is nearly the same whether or not the smaller eigenvalues of the inner product matrix are retained in the inversions. The double couple components generally account for more than 2/3 of the total moment. Normal faulting along an east to northeasterly strike characterizes the mechanisms in the principal zone of aftershock activity. Strike-slip mechanisms consistent with horizontal compression normal to the arc prevail in the delayed aftershock zone located 200 km northwest of the mainshock. Of the earthquakes subjected to this surface wave analysis the foreshock stood out as having felt a significantly higher apparent stress, perhaps as much as one half an order of magnitude higher than the others. These results suggest that accurate source parameters for moderate to small magnitude earthquakes could be routinely determined from surface waves recorded by the SRO's and ASRO's. In particular, the mechanisms of small magnitude foreshocks could be obtained in this way. (Focal Depths, Moment Tensors, Great Sumba Earthquake).
J. Geophys. Res., Red, Paper 1B0526

6970 Structure of crust and upper mantle
SEISMIC ANISOTROPY OBSERVED IN UPPER OCEANIC CRUST
R. A. Stephen (Woods Hole Oceanographic Institution, Woods Hole, MA 02543)
Seismic anisotropy in the upper 1500m. of oceanic basement has been observed by polarization analysis of three-component borehole seismometer records. The most convincing evidence for the anisotropy is shear wave splitting for explosive sources at four azimuths. Compressional wave particle motion deviations suggestive of anistropy are also observed but they may be caused by lateral inhomogeneities. The anisotropy was not resolved by travel-time analysis. The observed velocities and particle motions in the horizontal plane can be modelled to within a standard deviation by assuming a perfectly elastic, homogeneous, anisotropic layer 2 with hexagonal symmetry and a horizontal symmetry axis. The most probable cause of the anisotropy is preferred crack orientation.
Geophys. Res. Lett., Paper 1L0996

6970 Structure of the crust and upper mantle
STRUCTURE ALONG THE NORTHWEST EDGE OF THE SNAKE RIVER PLAIN INTERPRETED FROM SEISMIC REFRACTION
L.W. Pankratz (U.S. Geological Survey, Denver Federal Center, Denver, Co., 80225) H.D. Ackermann
The results of a seismic refraction survey at the Idaho National Engineering Laboratory along the northwest boundary of the Snake River Plain show that velocities of the volcanic rocks beneath the Plain increase from 1.8 km/sec at the surface to 5.2-5.5 km/sec at depths between approximately 2200-2500 meters. An exploration well in the area (INEL-1) encountered Cenozoic volcanic rock with some interbedded sediments to a depth of 2460 meters underlain by 760 meters of a rhyodacite porphyry. The refraction data demonstrate a nearly fault-like discontinuity of about 1000 meters displacement beneath the plain, about 1.8 km from the southeast flank of the Arco Hills (Lost River Range). Whether this discontinuity represents the northeast flank of the Snake River Plain graben, the east flank of the Lost River Range fault, or a caldera wall is not known. The results further indicate that Paleozoic rocks may extend beneath the plain as far as 5.6 km southeastward from the Arco Hills. (Seismic refraction, Snake River Plain)
J. Geophys. Res., Red, Paper 1B1055

6970 Structure of the crust and upper mantle
A COMPUTER MODEL STUDY OF THE PROPAGATION OF THE LONG-RANGE Pn PHASE
Joseph F. Gettrust (Hawaii Institute of Geophysics, University of Hawaii, Honolulu, Hawaii 96822) and L. Neil Frazer
Synthetic long-range (high-frequency) Pn phases that fit both the arrival times and, more importantly, the characteristic long coda duration of this phase are generated using a velocity-depth model consistent with long-range refraction and surface wave observations. These synthetics show that a crustal guided-wave plays an important part in the character of "typical" long-range Pn coda; in particular, the largest amplitude arrivals at ranges greater than about 8° propagate through the crustal wave guide. Comparison of a synthetic long-range Pn signal with an observation of this phase at 8° range suggests that any P-velocity inversion at the base of the lithosphere must be small. This result is consistent with the anomalously high Q values for Sn previously reported by other authors since a P-velocity inversion much smaller than the associated S-velocity inversion means that tunneling would extract much more low-frequency energy from long-range Sn than it would from long-range Pn. (Seismology, synthetic seismograms, crust and upper mantle, computer modeling).
Geophys. Res. Lett., Paper 1L0506

6970 Structure of the crust and upper mantle
A DIRECT MEASUREMENT OF THE DISTANCE BETWEEN A HYPOCENTER IN A BENIOFF-WADATI ZONE AND THE SLAB-ASTHENOSPHERE CONTACT
Joseph P. Stefani (Department of Geophysics, Stanford University, Stanford, CA 94305)
Robert J. Geller and Glenn C. Kroeger
We made a direct measurement of the distance from a hypocenter in the Benioff-Wadati zone to the boundary between the downgoing slab and overlying asthenosphere. This was accomplished by identifying a low amplitude P wave reflection off the slab-asthenosphere contact which arrives at teleseismic stations several seconds after the initial P arrival. The measured delay time (after P) of the reflected phase shows a consistent azimuthal variation, thus eliminating possible source or receiver effects. The relative amplitude, polarity and delay time of this observed phase are consistent with a model in which the distance between hypocenter and slab-asthenosphere contact at this depth is about 38±5 km.
The event studied was an intermediate depth (181 km) earthquake in the southern Kuriles which occurred in the lower layer of a double-planed seismic zone. Our measured distance, when compared to the distance between the two seismic zones, indicates that the upper layer of seismicity is within 15 km of the slab-asthenosphere contact.
J. Geophys. Res., Red, Paper 1B1011

6970 Structure of the crust and upper mantle
SEISMIC PROPERTIES, DENSITY AND COMPOSITION OF THE ICELANDIC CRUST NEAR REYDARFJÖRDUR
Nikolas I. Christensen (Department of Geological Sciences and Geophysics Program, University of Washington, Seattle, Washington 98195) and Roy E. Wilkens
Compressional and shear wave velocities, densities and porosities have been measured to confining pressures of 6 kbar for 135 samples from a deep borehole in eastern Iceland. The measurements are from a random sampling of dikes and sills through the 2 km hole. Velocities within the flow units are relatively low at the tops, reach maximum values within central portions and decrease near the bases. This systematic variation correlates well with variations in porosity and bulk density. The dike units, on the other hand, have relatively uniform velocities, which are approximately equivalent to maximum velocities measured within flow units. Below 700 meters, the dike and flow velocities show systematic increases with depth which are related to changes in mineralogy and independent of porosity. The velocity gradient (dVp/dZ), within this region is well defined by the laboratory velocities and approximates 0.6 s^{-1}, in good agreement with field refraction measurements. High velocities near the base of the hole are related to increasing alteration with depth and, in particular, an increase in epidote content. The abundance of epidote in the rocks recovered from the lower portion of the drillhole supports a metamorphic origin for the lower 2-layer 3 boundary in this region. (Iceland, velocity, density, basalt).
J. Geophys. Res., Red, Paper 1B1014

Solar Physics, Astrophysics, and Astronomy

7799 Solar physics, miscellaneous
NITRATE ION IN ANTARCTIC FIRN AS A MARKER FOR SOLAR ACTIVITY
E. J. Zeller (Department of Geology, University of Kansas, Lawrence, Kansas 66045) B. C. Parker
Firn cores from South Pole and Vostok stations have been analyzed for nitrate to determine if variations in concentration can be related to known variations in solar activity. Both analytical records are roughly 1200 years in length and are based on 1655 individual analyses from the 108 m South Pole core and 598 analyses from the top 47 meters of the Vostok core. Although the localities are separated by 1300 km, there is substantial similarity between the records and the Modern Maximum, Maunder Minimum and Medieval Maximum are present in both cores. Harmonic analysis of core data and associated snow pit studies imply a direct connection between solar activity and nitrate concentration in antarctic firn. (Solar activity, Antarctica, glaciology, ice chemistry).
Geophys. Res. Lett., Paper 1L0914

Tectonophysics

8130 Heat flow
THERMAL CONDUCTIVITY AND TEMPERATURE STRUCTURE OF THE REYDARFJORDUR BOREHOLE
E. R. Oxburgh (Department of Earth Sciences, Downing Street, Cambridge, England) and S. O. Agrell
One hundred and ten measurements of thermal conductivity have been made on samples over a 1900m depth interval in the Reydarfjordur borehole comprising largely basaltic flows and intrusives. The mean conductivity of both flows and intrusives increases with depth by about 25%, reaching a maximum value of about 1.9 W m^{-1} K^{-1}. This increase results from the growth of secondary minerals which progressively fill voids with depth and in some cases replace phases having lower values of thermal conductivity.
The conductive heat flow between [illegible] and the surface is about 100 mW m^{-2}. Below [illegible] the conductive heat flow appears to be less than half the near surface value and there is strong evidence that in this depth interval the thermal structure is modified by both thermal circulation. (Iceland, heat flow, conductivity, temperature)
J. Geophys. Res., Red, Paper 1B1054

8130 Heat flow
THE VREDEFORT RADIOELEMENT PROFILE EXTENDED TO SUPRACRUSTAL STRATA AT CARLETONVILLE, WITH IMPLICATIONS FOR CONTINENTAL HEAT FLOW
L.O. Nicolaysen (Bernard Price Institute of Geophysical Research, University of the Witwatersrand, Johannesburg, South Africa 2001) R.J. Hart and N.H. Gale
The dominant features of the geology in the Klerksdorp-Carletonville area in South Africa are a thick sequence of Precambrian stratified rocks of the Witwatersrand basin and the underlying Archean basement granite. The total crustal thickness is ~36 km and the average measured heat flow is 46 mWm^{-2}. At Vredefort, fifty km to the south of the Klerksdorp-Carletonville area, Archean granite forms the core of an updomed and overturned sequence of strata. Recent geochemical and geological studies provide evidence that the Vredefort basement granite has also been overturned, exposing a ~15 km thick section of the Archean crystalline crust. Profiles across the Vredefort basement, together with boreholes through the overlying stratified rocks, provide a unique opportunity of measuring the contribution of crustal radioactive heat production to surface heat flow. Adopting two extreme models for heat production in the lowermost crust, the total contribution to surface heat flow from radioactive heat generation in the crust is calculated at between 29 and 34 mWm^{-2}. Heat flow from the mantle in the Southwestern Transvaal sector of the Kaapvaal craton is estimated at between 17 and 12 mWm^{-2}. This low uppermost mantle heat flux is about half of that estimated for an oceanic lithosphere at equilibrium. Accordingly, the low flux provides evidence for a lithosphere thickness about double that of an old oceanic region. The unusually high estimate of crustal heat production, and the corresponding low mantle heat flow are due mainly to the occurrence of a heat production hump beneath an upper zone of exponential decline. Published statements that the reduced heat flow is an acceptable approximation heat flow at the base of the stable continental crust, are not supported by the present work. (Vredefort profile, heat flow, heat production, lithosphere thickness).
J. Geophys. Res., Red, Paper 1B1058

8150 Plate tectonics
PRESENT DAY TECTONICS OF THE SOUTHEASTERN CARIBBEAN AND NORTHEASTERN VENEZUELA
O. J. Perez (Lamont-Doherty Geological Observatory of Columbia University, Palisades, New York 10964) Y. P. Aggarwal
Four telemetered seismic arrays were operated in northeastern Venezuela during the summer of 1979, resulting in accurate locations for about 100 microearthquakes and four new focal mechanisms. On the basis of these new data, an in-depth analysis of teleseismic data, and geological evidence, we propose a new tectonic model for the southeastern Caribbean. In this model, underthrusting of the Atlantic sea floor along the Lesser Antilles is extended to the southeast of Trinidad. The subducted slab is shown to dip northwesterly beneath Trinidad and the Caribbean Sea, penetrating depths of at least 150 km. This subduction terminates in the vicinity of the Los Bajos-El Soldado fault zone, that trends WNW-NW and is located in the Gulf of Paria west of Trinidad. Geologic evidence shows right-lateral, strike-slip (RLSS) motion in this fault zone, probably initiated in the late Pliocene, coeval with imbricate thrusting in central Trinidad. This WNW-NW trending fault zone joins up with the E-W trending El Pilar-Casanay fault system in northeastern Venezuela, that also moves right laterally. The El Pilar fault is apparently offset by NNW trending faults that exhibit RLSS motion as well as normal faulting. The extension of the El Pilar fault zone northern Trinidad does not play a major role in this model. This complex deformation pattern is interpreted to be the result of WNW motion of South America relative to the Caribbean plate. In our interpretation, the E-W component of relative motion is accommodated by RLSS motion on E-W faults and results in normal faulting on NNW-SSE faults. The smaller component of N-S convergence is reflected by RLSS motion on NNW trending faults and is accommodated by some internal deformation. Several lines of evidence suggest that this complex mode of strike-slip motion began only a few m.y. ago, is apparently contemporaneous with other events elsewhere in the Caribbean, and that the average rate of relative plate motion in this region is [illegible]
J. Geophys. Res., Red, Paper 1B0760

8150 Plate Tectonics
THE UNCERTAINTIES OF FINITE ROTATIONS IN PLATE TECTONICS
S. J. Hellinger (Suite 7, 247 Harden St., Cambridge, Ma. 02138)
Incomplete knowledge of the pattern of magnetic lineations and fossil transform faults represented by sea floor spreading data on two plates generated by the same spreading center leads to uncertainties in a reconstruction of the past relative configuration of the plates. A reconstruction may be represented by the finite rotation that describes one configuration relative to another. In this paper a method of reconstruction is provided that reflects the uncertainties in the data. The method minimizes a weighted least-squares measure of fit as a function of the rotation parameters. For a given rotation the measure of fit represents the sum of squares of the weighted distances of fixed and rotated data points (representing corresponding former plate margin segments) from a common plate margin. The common margin is estimated from the locations of both fixed and rotated data points. The estimated margin consists of a set of great-circle arcs. It is shown how the method of reconstruction may be utilized to obtain an uncertainty region for the pole and angle of rotation that characterize the finite rotation. These techniques are then used to study the uncertainties of reconstructions in the South Pacific for the times of anomalies 13 and 18. The best-fit reconstructions and the uncertainty region for the anomaly 18 pole are in good agreement with previous work. However, the uncertainties in the anomaly 13 pole were substantially underestimated by previous investigators.
[illegible], Red, Paper [illegible]

8199 General or Miscellaneous
PERMEABILITY AND FRICTIONAL PROPERTIES OF SAN ANDREAS FAULT GOUGES
C.L. Chu and C.Y. Wang (Department of Geology and Geophysics, University of California, Berkeley, California 94720), and W. Lin
The permeability of a San Andreas fault gouge is determined under confining pressures up to 220 bars; it decreases with pressure from 20 nanodarcy at 15 bars to 0.3 nanodarcy at 220 bars. These values are lower than the values determined by Morrow et al. (1981). Five different samples of fault gouge with significantly different grain-size distributions were sheared between rock joints under confining pressures to determine the effects of grain size and constitution on the strength of the fault gouge. The strength of fault gouge clearly depends on its constitution and grain size distribution, with the coarser sandy fault gouge being stronger than the finer clayey gouge. Furthermore, the coarser gouge tends to strain harden after yielding, leading to greater strength. Thus, on the San Andreas fault, inhomogeneities in gouge materials may cause spatial variations in strength. Using the permeability determined above, we estimate that the excess pore pressure generated in the fault gouge samples during the experimental shear loading may be negligible. (Permeability, grain size distribution).
Geophys. Res. Lett., Paper 1L0619

Izvestiya Physics of the Solid Earth
Volume 16, Number 1

CONTENTS

SCIENTIFIC COMMUNICATIONS